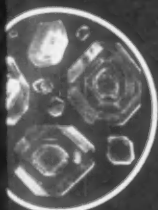


The Story of Steel

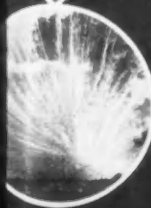
CHEMISTRY

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Steel for War and Peace.....	1
Colored Smokes.....	9
Tungsten, Molybdenum Available.....	10
Ten Most Important Remedies.....	11
Future of Industrial Research.....	12
Physicists Plan Unified Organization.....	22
Waste Fats as Rocket Propellant.....	23
Industrial Electronics.....	25
Chem Quiz: Old Salts.....	27
Health Often Linked to Diet.....	28
Life-Chemistry Genetics Problems.....	31
Periodic Table of the Chemical Elements.....	32-33
Elements and their Chemical Properties.....	34
New Patents in Chemical Field.....	37
Classics of Chemistry:	
The Sweet Element.....	42
Who's Who in Beryllium.....	51
The Work of the Chemical Profession:	
III. Training for the Chemical Profession.....	52
Kosower: Modified Willgerodt Synthesis.....	57
Joswick: Minerals and Metals.....	61
Editorial:	
Catch Them Young.....	
Inside Front Cover.	

25¢

Catch Them Young

► THE HISTORY of chemistry and other branches of science is full of largely unwritten chapters of scientific biography. . . . let's start over and put it something like this:

Perkin discovered mauve when he was 17. A thousand other chemists discovered chemistry at 10 or 12 or 14. They discovered the great fun of doing experiments in their basements or attics or barns. That is when chemists are born.

Dig into the real life story of great scientists and you will find that they started early, some earlier than others, but most of them when they were still in school.

It is old folks—people who were never young with the touch of wanting to find out how and why—who fail to recognize that future scientists should start experimenting just as soon as they can.

Read in this issue the essays of Kosower and Joswick, top boy and girl in this year's Science Talent Search, to see what extraordinarily talented high school seniors can do and do do. Fortunately they got to work in chemistry very early. Fortunately they have just made a beginning, and have acquired the responsibility of going on through college and further to equip themselves for full-fledged creative research.

We need to spot such boys and girls of potential scientific talent long before they are ready for college. If we knew enough we should be able to locate them at about the age of 10. Even earlier we need to mold our school and play so that from nursery school onward all children learn the scientific methods and facts as naturally as they learn to talk.

That may well be science's biggest task today.

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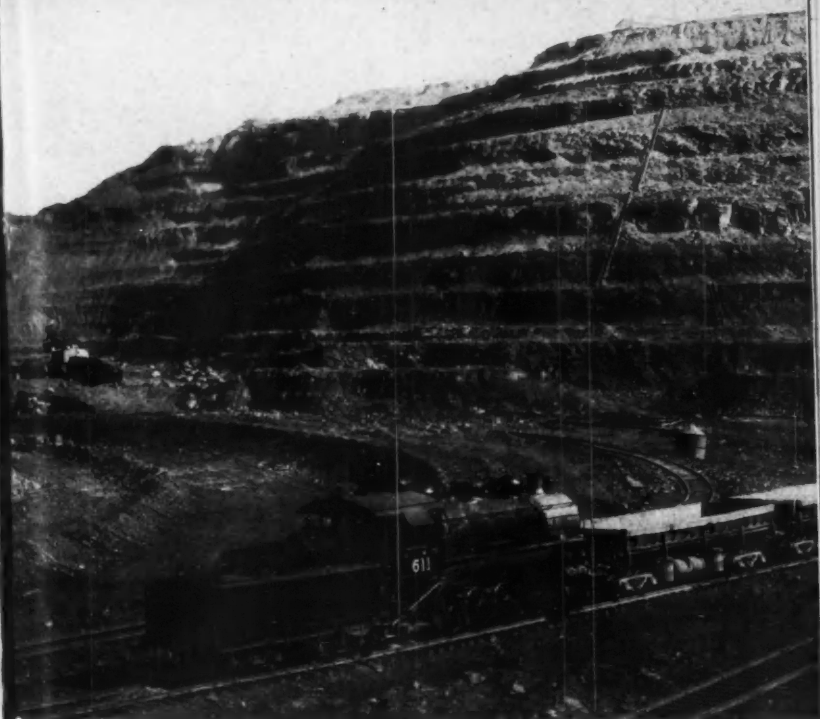
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► IRON ORE occurs in relative abundance in the top crust of the earth. Although some iron comes from underground mines, the open cut of the famous Mesabi Range, Minnesota, shown here is the typical source of ore for present-day large-scale iron production.

Steel for War and Peace

by MARTHA G. MORROW

► THE LADY WELDERS of today may just be getting into practice for mend-their post-war hosiery. Stainless steel can now be drawn into wires as fine and nearly as flexible as the threads used in silk and nylon manufacture. It may be just a step to the stainless steel stocking.

For other purposes, stainless steel

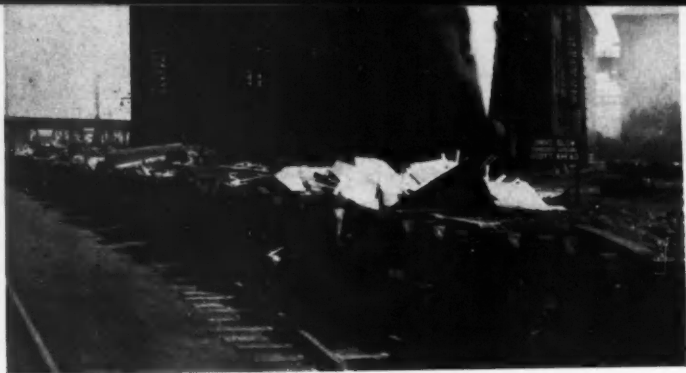
may now be made either white or black. Research is under way to develop it in color, so that instead of having the car repainted every few years you may get one with a permanent color throughout its cross-section.

Combinations of steel and plastic bonded together have been developed recently, and the combined material is

APRIL 1945

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➤ *SCRAP IRON can go back to the steelmaking furnace to be re-melted and converted into steel. Salvage material occasionally forms a small part of the blast-furnace charge.*



➤ *LIMESTONE is the flux which melts the ore and combines with the part that isn't iron to form the slag. This typical limestone outcrop is being quarried for the blast furnace.*



giving excellent service as boiler tubes and in vital parts of machinery for the manufacture of pulp and paper, essential oils and rayon. During the last four or five years plastics that resist heat and corrosion have been successfully and economically used as a coating and lining for steel pipe and tubes.

Some of the alloy steels produced for the first time during the war may help build the automobiles, trucks and refrigerators of peacetime. Some of the new methods of treating and fabricating steels to make submarine skins or airplane wings will undoubtedly prove useful when the war has become a thing of the past.

Four years ago we were unable to produce the tungsten-free steel that now makes the tough, hard core of the armor-piercing shot our guns blast at the enemy. There were no all-steel automobile bodies until about ten years ago. Early in the century there was no cutlery steel that would not rust, and we lacked the stainless steel surgical instruments that are now saving lives in our field and base hospitals. Steel is ever being improved and finding new uses.

Approximately one and a quarter billion tons of steel have been made in this country in the past seventy years. Railroads, bridges and skyscrapers have been built of it. Some of it has gone into hairpins, some into razors, and some into refrigerators. About two tons of steel before the war were used in building and equipping a home, and an average of 600 pounds of steel per person was used for all purposes in the United States.

Steel, like iron, is made from iron ore—for steel is an alloy of iron and carbon. Most of the ores used are iron oxides, similar in chemical composition to the rust that forms on a piece of iron or steel that has been exposed to the elements. The ores contain about 50-55% iron, with oxygen and other elements such as silicon, aluminum, manganese, calcium, phosphorus and sulfur making up the rest. Some ores are compact, granular masses; others are a loose, powdery earth. They vary in color from a metallic black to a brick red.

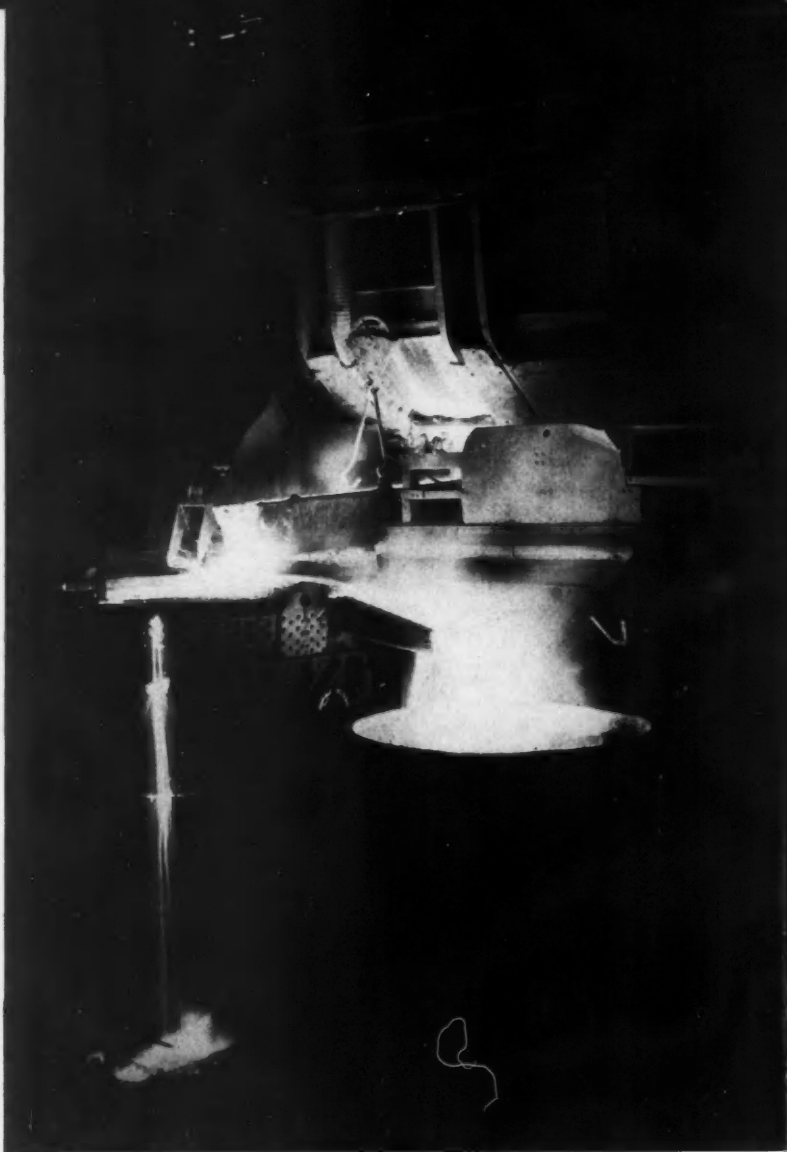
The qualities of steel vary with the amount of alloying materials. The percentages of these materials is very low, however, steel being almost entirely iron. Only a few hundredths of one per cent up to about 1½% of carbon is needed to make the difference between iron and steel.

Over 63,000,000 tons of finished steel were shipped from steel plants throughout the country last year. During the first three years of the war more than 300,000,000 gross tons of iron ore were shipped from the nation's mines.

For every ton of iron ore that is charged into a blast furnace to be made into pig iron, one-half ton of coke obtained from coal and one-fifth of a ton of limestone must also be used. During 1943 the nation's blast furnaces used up over 24,000,000 tons of limestone and the coke produced from about 81,000,000 tons of coal, in addition to the coal needed to make steam for the plants.

The steel industry uses about as

► *THE COAL MINER, opposite, usually has to go deep underground to dig fuel out of seams in the rock. Coal is changed to coke before it goes into the blast furnace, and many valuable by-products result from the treatment.*



► ONE ESSENTIAL PART of steel production is the separation of the molten metal and slag. The tall ladle at the left in the picture has just been filled with metal. A protective layer of slag is allowed to float on the top. The excess runs into the slag ladle at the right and cascades over the side of the steel ladle.

► MELTED IRON from the blast furnace is pouring from the ladle into the openhearth furnace where it will be changed to steel. Steelmaking refining processes consist largely of oxidizing unwanted elements and holding them in the slag.

much steel scrap as pig iron. About half of the scrap comes from the iron and steel works themselves. Steel ingots are cropped before rolling into finished products, and that makes scrap. When rolled products are sheared or trimmed, more scrap is created. Old rolling mill rolls wear out and become scrap.

The rest of the scrap comes from the scrap dealer, who collects the bits of steel left after body panels, fenders and headlamps for automobiles have been punched or shaped from flat steel sheets; who buys worn-out cars, rails, axles and car-wheels from railroad companies; and scavenges for old automobiles, worn-out machinery and shavings from machined steel.

Nineteen million tons of slag, drawn off from the molten steel upon which it floats, were utilized in construction last year. Used as concrete blocks in building factories or warehouses, as ballast in many of the important railroads, in paving city streets and roads for many of the Army camps and

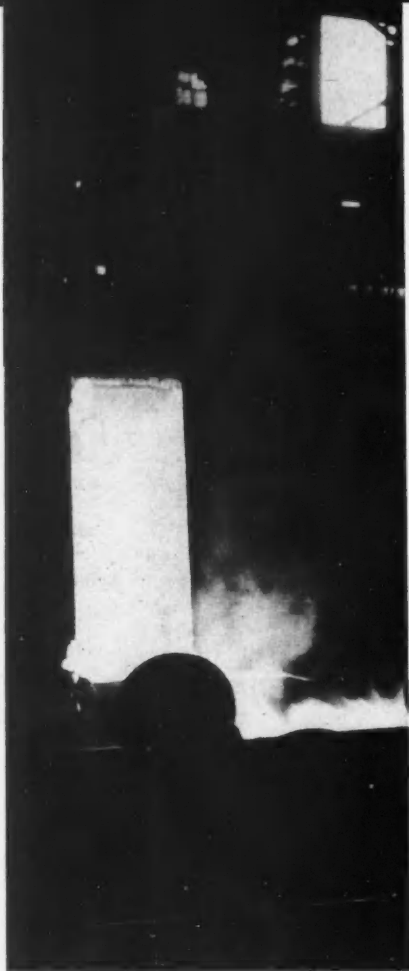


Naval bases, and in constructing and maintaining airport runways, this steel byproduct finds many uses.

The amount of steel used to make planes, guns, tanks and ammunition, though large, is only a fraction of the total wartime requirements for steel. Steel is needed for the machinery to make these weapons and the plants to house it. Emergency oil and gas pipelines are made of steel, and the lunchrooms in new plants are equipped with it.

Steel companies manufacturing file cabinets, garbage cans, bridges and railroad cars soon after war began were called upon to produce ships, bombs and rifle sights. One company now regularly turns out one of the big shells used by the Army every 12 seconds. Another company during 1943 delivered an average of one ship a day. Tens of thousands of prefabricated steel barracks buildings, field

► IN THE MODERN electric furnace the purified iron may be modified by addition of other elements which will give desirable properties to the resulting steel. Vanadium, tungsten, molybdenum and nickel are among the metals so added.



► CAST INTO INGOT form and held at white heat in the "soaking pit," this cylinder of steel is rolled out into a bar that grows longer and narrower as it travels through the rolling mill.

hospitals and other types of military buildings in that same year were manufactured by still another company.

The ingenuity of the steel workers themselves helped meet the enormous wartime demand. A rolling mill superintendent in Michigan and his crew figured out a way to use ordinary furniture casters as emergency bearings on the cooling bed of their rolling mill. To get the casters, they routed a hardware dealer out of his Sunday morning sleep to open up his store so the steel could be delivered according to schedule.

A furnace repair crew in Ohio, willing to run great personal risks in order to keep the metal rolling, did an emergency repair job on a hot blast furnace. By not waiting for it to cool, they saved several days of production.

The first company to produce rolled armor for tanks and planes practically ran a school for armor makers. Other companies were invited to send their men to the plant to see in detail how the work was done.

A speed-up in the shipbuilding program, particularly of Liberty ships, meant that the plate steel capacity of the industry had to be doubled in a minimum of time. Plants that had been producing automobile bodies, refrigerator cabinets and tin cans, were pressed into service. Others, formerly equipped to produce strip sheets (a much thinner metal) were converted with practically no loss in production.



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In making steel, excess impurities must be removed from the pig iron, and the quantity of these elements other than iron which are an essential part of steel must be controlled. Although the term "alloy steel" is applied only to certain steels, all steels are alloyed to some extent. Besides iron, they contain carefully controlled amounts of carbon, manganese, phosphorus and sulfur.

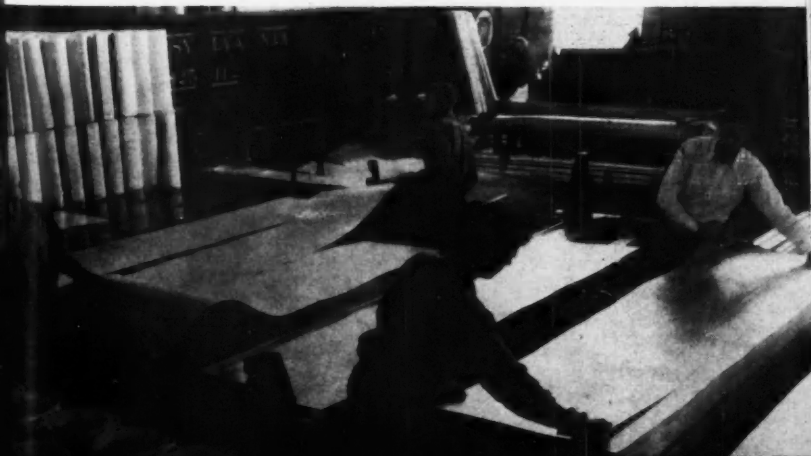
Various alloys like nickel, chromium, vanadium and molybdenum are used to make "super steels" that are harder, or stronger, or more heat or rust resistant than the usual product. Before the war alloy steels, used for stainless steel cutlery and automobile engines, averaged only three million tons a year, approximately 6% of the total steel production. During the peak year of 1943, however, almost 1,300,000 tons of steel alloys were produced in a single month.

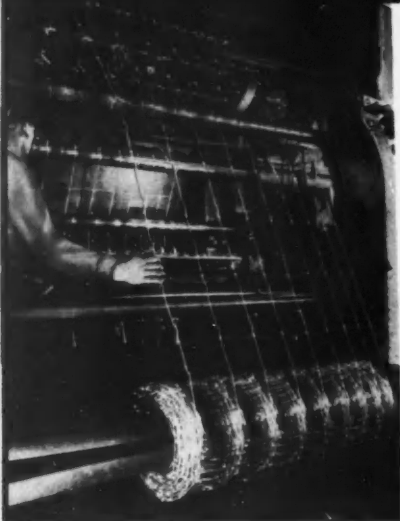
Many of the steels made in peacetime found wartime applications. A big army truck needs just about the same kind of alloy steels for its engine and transmission as a heavy duty truck built to haul fuel for civilian oil burners. Alloy steels used in machine tools for making farm machinery are essentially the same as the steels used for machine tools to make gun mounts or aircraft engines.

Alloy steels that differ from regular commercial steel, however, were also needed. The steel used to make the outer skin of a submarine has no peacetime counterpart. Nor have the steels for armor-piercing shot or rolled tank armor.

In the early stages of the war, shot steel capable of piercing the armor of Rommel's tanks was made of an alloy containing about 6% tungsten. But as the war progressed, not enough tungsten was available and a substitute alloy

► *MALLEABILITY AND DUCTILITY are more than long words to iron and steel men. Blooms from the rolling mill are flattened into sheets for many purposes. Some are galvanized for protection from rust, and show the characteristic crystal pattern of the zinc coating.*





► WIRES ARE DRAWN out thin and fine for uses that stretch from piano strings to fences. Mechanical looms weave fences, with or without barbs.

steel of equal quality had to be developed.

Two commercial alloy steels, when modified, proved to be as good at piercing armor as the 6% tungsten steel. The nickel-chromium-molybdenum alloy steel had been produced for truck gears, and the manganese-molybdenum alloy had been used for the jaws of ore crushers.

We are wholly or in part dependent upon foreign countries for our supplies of five of the seven principal alloying elements—chromium, cobalt, manganese, nickel, and tungsten. When our supply of these elements was diminished or entirely cut off, a number of new alloy steels had to be developed to give the strength, hardenability and ductility needed. Small percentages of

two, three or four different alloys, rather than a large amount of a single alloy, were used in a new series of steels called the National Emergency Steels.

For some time metallurgists have known that when two or more elements are equally effective in strengthening steel, a steel containing 0.5% of each would be stronger than a steel containing 1% of any one element. It has been supposed, however, that multiple low-alloy steels would be harder to heat-treat.

The first substitute steels were announced in the early spring of 1942. As strong as standard alloy steels, only one third as much alloying materials were used in making them.

Photographs of the Mesabi Range, page 1, iron scrap, limestone quarry and coal mine on page 2, and furnace on page 4, are by courtesy of the U. S. Steel Corporation. Photographs of furnaces on page 5, views in steel mill on page 6, pictures of sheet iron and wire on pages 7 and 8 are by courtesy of the American Iron and Steel Institute.

Chemical Warfare Provides Bright Hues for Signaling Between Troops

Brilliant Colored Smokes In War

► **COLORED SMOKES**—bright-hued greens, yellows, reds, blues, and other colors—are being used extensively by American fighting men in this war for many kinds of signaling.

"Colored smoke is used for ground to air and ground to ground signaling, distress signals for grounded aviators, life-boat distress signals, ranging and spotting signals, and parachute markers," it is pointed out in an article contributed by the Technical Command of the Chemical Warfare Service to Chemical and Engineering News, publication of the American Chemical Society.

"The multitude of uses is constantly growing. The colored smoke signals are used in hand grenades, rifle grenades, mortar shells, bombs, rocket projectiles, and shells of practically all calibers."

Only smokes of definite and unmistakable colors are used, except in certain cases, to avoid confusion with gray, white or black smokes produced on the battlefield by high explosives, by screening smokes, or by burning equipment or structures.

Signal smokes, the Technical Command said, can be made by dispersion of finely powdered materials, by chemical reactions which produce colored smokes, or by volatilizing colored materials. Only the latter method has been found feasible for smoke of high volume and high color intensity.

"Organic dyes and dye intermediates have been found to be the only practicable colored materials suitable. Except for black smoke, all the colored smoke signals are based upon volatilization of dyes and dye intermediates. The dyes found feasible are mainly anthraquinone derivatives.

"The colored smoke compositions are essentially pyrotechnic mixtures of a fuel, consisting of a combustible material and an oxidizing agent, a dye, and sometimes a cooling agent.

"The heat produced by the reaction of the fuel constituents volatilizes the dye which condenses outside the munition to form a smoke. A cooling agent which may be added serves to regulate the rate of the burning of the fuel and lower the temperature of combustion so as to prevent excessive decomposition of the dye, evidenced either by decolorization or strong flaming."

The only oxidizing agent that was satisfactory in the fuel mixture was potassium chlorate, with sugar one of the best combustible materials. The best cooling agents were found to be either sodium or potassium bicarbonate.

In investigations of dyes, the anthraquinone dyes were found "superior to all others in producing smoke clouds. The azo derivatives furnished only very few suitable dyes, and in no case were these superior to the anthraquinone dyes. Their defects are their

tendency to flame and to produce transparent smokes. Among the azine types, rosindone and its derivatives gave excellent bright smoke clouds without any flaming. Their color range, however, is limited to red and orange. This class of dyes offers the

most promise for future investigation."

Besides burning-type colored smoke mixtures, colored smoke bursts can be obtained by mixing dyes and powder which when detonated give a large puff of colored smoke.

Tungsten, Molybdenum Available

► TUNGSTEN and molybdenum, rivals for favor in the war-essential rare-metals family, are now available in sufficient quantities to meet the most important needs, among which are the 15,000 types of items used mostly in electric lamps and electronic tubes, according to the lamp division here of the Westinghouse Electric & Manufacturing Company, one of the largest American producers of pure tungsten for electrical uses from imported wolframite ore. Its production of tungsten from the imported ore is now 16 times as great as in prewar years, and the production of molybdenum, from an American ore, has increased to about the same extent.

In prewar years tungsten ore came principally from countries now wholly or partly under Japanese control. Chinese ore is reaching the United States, but it has to be brought by aircraft transport into India and shipped from there by boat. The United States is one of the principal molybdenum mining and smelting countries.

For use in electronic tubes and lamps, both tungsten and molybdenum must be in a high state of purity. The processing of both requires intricate and precise handling. The metals are reduced to powder form and later pressed into ingots strong enough to be drawn into very fine wire or to be

formed into rods and sheets. Both these metals have high melting points, both have electrical conductivity about one-third that of copper, and both compare favorably with the more expensive metals, platinum and tantalum, in their ability to resist corrosion.

Tungsten is slightly superior to molybdenum in some respects, but it is limited as to size and form and weighs twice as much. It is one of the heaviest of all metals. It has the highest melting point of all. High-speed cutting tools are approximately 20 per cent tungsten, and can be used on a lathe until red hot without losing hardness. Tungsten alloys, particularly steel alloys, are used extensively in many types of machines and especially in war munitions.

Molybdenum is a silvery white metal with a high melting point, and is used extensively in steel alloys to increase tensile strength, as well as in electric lamps and electronic tubes. It is also used in high-speed cutting tools as a substitute for tungsten. In steel alloys it is particularly valuable in protecting against corrosion, and especially against sulfur corrosion. It is called indispensable in vacuum tubes and all other electric equipment where high conductivity, great strength and rigidity at high temperatures are required.

Contrast Between 1910 and Now In What Physicians Find Useful

Ten Most Important Remedies

► PHYSICIANS in the year 1910, according to the Journal of the American Medical Association, listed the 10 most important drugs used in medicine in the following order: ether, morphine, digitalis, diphtheria antitoxin, smallpox vaccine, iron, quinine, iodine, alcohol and mercury.

Today, the journal says, a list of the most important remedies might be: penicillin and the sulfa drugs and antibiotics; whole blood, blood plasma and blood derivatives (these would include gamma globulin for protection against fibrin films and foams to aid the surgeon and albumin for shock); quinine and quinacrine; ether and other anesthetics such as morphine, cocaine, and the barbituric acid derivatives which the layman knows chiefly as sleeping tablets; digitalis; arsphenamines; immunizing agents and specific antitoxins and vaccines; insulin and liver extract; other hormones; and vitamins.

The list was made after questioning some of the professors of medicine in leading medical schools. Such a tremendous advance has been made in treatment of disease that it was found almost impossible to list 10 individual remedies as the 10 most important or useful. Penicillin was put first in most of the answers, but other antibiotic drugs were added and the sulfa drugs came very close to penicillin.

"Actually," the editorial states, "the choice of the most important remedy depends on the condition with which the physician is confronted. For malaria there is no question about the value of quinine or quinacrine; for asthma, epinephrine or aminophylline would seem most important. For amebic dysentery emetine, chiniofon or carbarsone would be the choice. If the patient just happened to have postprandial indigestion, baking soda might be considered the sovereign remedy."

Nylon Suit Protects In Arctic Waters

► AIRMEN dunked in near-freezing arctic waters in sub-zero weather after ditching their planes at sea may owe their lives to a new all-nylon anti-exposure suit that is coated with an unstated substance to make it both water-tight and air-tight.

The protective cloth of the suit covers everything but the face. It was developed by the Personal Equipment Laboratory of the Air Technical Service Command, Wright Field, Ohio.

Under ordinary conditions an airman's survival in water 15 degrees above zero is a matter of minutes. It is reported to be one of the worst situations that a man can face.

During tests, airmen wearing the suit have spent an hour in water at very low temperatures. By use of thermocouples, scientists observed that at no time was any part of their bodies more than a few degrees below normal. The men themselves reported experiencing no real discomfort from cold.

The Future of Industrial Research

by THOMAS MIDGLEY, JR.

This was the last paper presented by Dr. Midgley before his death on November 2, 1944. He delivered the paper by telephone from his home in Ohio to the Silver Anniversary Forum on the Future of Industrial Research, sponsored by Standard Oil Development Company in New York on October 5, 1944. Dr. Midgley was president and chairman of the board of the American Chemical Society.

► SOME TWENTY-FIVE or thirty thousand years ago a new species of animal appeared on this earth. There is nothing remarkable about new species appearing from time to time. The history of the ages is filled with such events; but this particular species differed in one characteristic from all that had preceded it. Instead of adapting itself to the various environments thrust upon it by an unfriendly and ever changing world it had an instinct to adapt its environment to suit itself. Indeed this was the most remarkable characteristic it possessed. It began by exterminating all of its potential competitors within the genus homo, leaving only itself as the representative of that group. Recently it has given itself the species designation of sapiens. Homo sapiens, or in other words, ourselves, began the readjustment of its environment by doing the obvious. It cleared land for agriculture, built houses for protection against the weather and various enemies, includ-

ing itself and, to a limited extent, destroyed those animals antagonistic to it as best it could. It made into vassal creatures dogs, cattle, chickens and pigs and changed the nature of many wild plants to make easier its labor of providing itself with food. Yet there remained many parts of its environment over which it could exert no control, for example, lightning, hurricanes, earthquakes and floods. This lack of control puzzled it. Instinct urged it on and somewhere in its subconscious mental processes mankind felt that a better understanding of that universe, which it knew to be its own, might aid it in its eternal fight to control that universe. At first imagination was given full sway. Superior creatures to itself were conceived of which it assumed had control of many things. Sacrificial offerings and prayers were invented to obtain the friendship of these superiors; but gradually, through the past two thousand years, such childish superstition has been replaced by what we call the scientific process.

What is this scientific process? Indeed, all too often the term is used to glamorize simple common sense and then again it is used by charlatans to give respectability to what otherwise obviously would be in conflict with common sense. A better definition is desirable. To my mind the basis of the scientific process is the reproducible experiment.

Facts are still, and probably always will be, determined by vote; quite as the College of Cardinals determined the number of feathers in the Archangels' wings just a few centuries ago. To the modern scientifically trained mind this process seems somewhat ridiculous; but was it? The number had to be determined for the benefit of painters, sculptors and architects and how else could it have been done? Indeed, the same process is in use today when groups of scientists gather to hear discussions of controversial subjects. There are, however, two points of basic difference. Whereas the number of feathers was decided by majority vote, in science we require a practically unanimous vote for establishing a fact. The second point is the type of evidence required by the voter to influence his decision. Revelations, dreams, supernatural authority are now out, and even logic is of secondary importance to the reproducible experiment.

Mathematics is the only branch of science which claims exemption from this rule. Two thousand years ago, mathematics passed from the realm of the experimental to the utopia of pure logic. It is interesting to note that prior to that time mathematics had been an experimental science. The Egyptians and Babylonians had determined crude values for π by experimentation, and several formulas had likewise been developed. The Greeks, however, who were long on logic and short on experimentation, transformed mathematics into an exact science; the only transformation of its kind ever to have taken place. Is it too much to hope that other sciences, such as chemistry and physics, may some day be similarly

transformed? One may always hope, even though fulfillment is still far away.

Permit me to recapitulate. We are the only species of living creatures that even conceives of exerting any control over the environment thrust upon it. Admittedly, this control is far from complete. Its extension is greatly to be desired. To accomplish this extension we need to increase our knowledge of the universe in which we live. The only fundamental tool at our command, for extending this knowledge, is the reproducible experiment. This is the accepted scientific method, and when applied to obtain a better understanding of our environment is designated by such terms as fundamental research or pure science research or academic research. Once new facts about our environment (which is synonymous with our universe where and when we contact it) are discovered we can make use of these new facts to alter or control our environment to some extent. The process of applying the facts, determined by fundamental research, to a better control of our environment is called applied research or development work or invention.

For some reason, best known to our lawmakers, the discoverers of new facts are denied any special rights to financial benefits that ultimately may result from these discoveries. On the other hand, those who can apply such discoveries to improvements of environment, for their fellow men, are granted the exclusive privilege of exploiting these improvements, for a limited period of time, providing they make public the nature and details of the

improvements in documents called patents.

Whether this arrangement is right, fair or just is beside the point. Under its influence modern industry has come into existence and homo sapiens has made great gains in controlling his environment. This, at least, makes it good.

In the early history of modern industry there is little evidence that it either knew or appreciated the fact that the patent system was responsible for its birth. All it knew or cared about was that it had a steam engine to run machines with, that machines could be operated by men hired at low wages to make things that could be sold at a profit. Little did it care that the steam engine had been developed by James Watt because James Watt knew he could get a "patent monopoly" on the results and sell steam engines at a profit. Few of the early units of our "modern industry" gave heed to the fact that they could follow in the footsteps of James Watt and increase their profits by contributing to the inventive and developmental process. Thus it was that, for over a century and a half, the inventor went his lonely way, suffering hardship and sacrifice, often being looked upon as crazy and finally spending the later years of his life in protecting the rights granted to him by his government. If you think this an exaggeration study the life of Charles Goodyear and then ask yourself if it was worth it, just to stand in the Hall of Fame, where he should be, but isn't.

Inevitably industry finally saw the light. Many of you can recall the "drafting room" of fifty years ago, how it grew into the engineering de-

partment which in turn gave birth to the research laboratory.

Industrial research has come into existence by this revolution. The field of industrial research is restricted, primarily, to making use of the discoveries of academic research to improve our control over our environment which then may be used for profit making through the patent process. It must be noted, however, that our knowledge of our environmental universe is far from complete and that it often becomes necessary, in the course of prosecuting industrial research, to deviate from the primary process in order to determine additional facts about the universe so that these facts may be applied. There is no legal process for restricting the use of these facts, once determined. Secrecy and secrecy alone can retain control. This is not quite as it should be. There might be some mechanism devised whereby the discoverer of new facts could preempt their use for a brief period of time; a period at least long enough for him to determine some of their various applications to environmental control. Thus would be established a motive for industrial research to make public, at once, the discoveries it makes concerning the natural laws. I should like to point out that, despite the profit motives to keep secret the discoveries of fact which are continuously being made by industrial research, the large majority of industrial operators do make these discoveries public within a reasonable time. Such an attitude of conscious service to society should receive more praise and recognition than it does.

Instead of trying to aid industrial research to benefit the society which

has created it, it seems inherently human for many people to do their utmost to obstruct it. Possibly the suddenness with which industrial research has developed to its present position of eminence has generated unwarranted fears on the part of many people who scarcely understand it; fears that the power it obviously possesses over our future progress may be abused; fears that a monopoly of brains may be in the making, or just plain fears of change. Whatever the fears may be, I am of the opinion that their basic cause is simply the sudden appearance of industrial research in our economy. Had industrial research developed simultaneously with modern industry over the past one hundred and fifty years instead of merely during the past twenty-five (to a large extent), these fears would be non-existent. That industrial research should have been developing over the one-hundred-and-fifty-year period seems obvious to us now; its rapidity of growth during the past twenty-five years has been largely a "catching up" process. Whether or not it has completely caught up with other industrial activities is a question for debate. I am of the opinion that it has not. Assuming that I am right in this opinion there is still a further point for debate. Will it? This is a far more difficult question to answer than the first. It hinges on so many intangible factors, factors which only the future itself will fully develop.

I should like to discuss a few of these factors at random, more for the purpose of disclosing the uncoordinated thinking that is taking place rather than to attempt a solution of any one of them.

For example, there is one school of

thought that was rather vociferous some ten years ago, which believed that all industrial research should be ended for some indefinite period, until, as they expressed it, the humanities had caught up. Since the war developed, these theorists have been rather quiescent; but given a period of unemployment, after hostilities cease, it is a practical certainty they will be heard from again. Frankly, the thought processes involved are beyond my poor comprehension. How unemployment may be reduced by increasing it or how stopping industry will start employment is merely a denial of logic to me.

Then there is the thought that placing all industrial research under government direction would result in accelerated progress. I have read the various Kilgore Bills and the arguments for and against; but again I must confess that I simply cannot understand the logic involved. Somehow, it seems to me that the proponents of this and similar proposals assume that research scientists are going to work largely for the pleasure of presenting the results of their labors to society free gratis, without any desire for rewards for themselves. There are such men of course. Thank God there are, for, without them I don't know how we will ever get the next generation of college students educated, but there are none to spare. It is quite true that scientists, as a group, are more willing to work for the sheer joy of satisfying their inquiring minds than are most other people; but it is also true that scientists have wives who want new automobiles and fur coats, quite as physicians' and lawyers' and judges' wives do, and scientists have children,

just as other folks do, and scientists like to feel that they can raise and educate these children, as other folks do, and to do it they are deserving of an opportunity to obtain a financial reward that is somewhat proportional to the services they render society. I have never been able to figure out where they get it under the Kilgore proposal.

There are also those who would change our patent system. Somehow these people have an aversion to the government granting a monopoly for seventeen years to any individual for making public an invention. These people seem to think the government is giving away something to the inventor. Actually, by its very nature, a patentable invention brings into existence with it a natural monopoly, which merely requires secrecy for its preservation. Obviously, the commercialization of many inventions would destroy the secret; but others would not. In either case the inventor could retain his natural monopoly and use it for his own benefits in whatever way he might choose as long as he did not disclose his secret. This is the situation the inventor finds himself in when he goes to the government voluntarily to accept the bargain the government offers him, which simply is this: "Make your invention public and you can *retain* your monopoly for seventeen years." If the government decides to drive a much harder bargain it is permissible to wonder how many inventors will volunteer to surrender their natural monopolies. Certainly those who make an invention which may be exploited and kept secret will scarcely be expected to do so. The results will be disastrous.

Then, too, there are court decisions that are difficult to understand. The Supreme Court declares that Marconi's patents are invalid for lack of invention after they have expired. In another decision it uses the term "flash of genius," as though the method of making an invention was of more importance than the invention itself. Another court proclaims that an individual can make an invention; but if a group, working together, perform the same act and obtain the same result it is not an invention. It is all very disconcerting. To my way of thinking, which I have tried to develop in the early part of this discussion, any increase of control over our environment, or beneficial alteration thereof, is invention. The method by which such results are obtained is of no importance. The attitude of these courts seems to be comparable to a general deciding that if a regiment takes a position from the enemy no advance has been made, whereas if a single individual does so it is a commendable act and deserving of a medal—in the court cases, a patent.

Some few years ago the enemies of our patent system were in the habit of proclaiming that there were great numbers of "suppressed" patents. A "suppressed" patent was supposed to be a patent of value that was not being "worked" because of some selfish motive on the part of the owner, such as having an obsolete plant that he would be forced to scrap if he put the patent to work. This story has many variations. Then these propagandists proposed new laws for forced licensing as a corrective measure of this imaginary abuse of our patent system. In the interest of determining the facts, I is-

sued an invitation in the News Edition of Industrial and Engineering Chemistry to any and all chemists who might know of such cases, to report them to me anonymously, giving the *serial number* of the patent. I received five replies. Not a single case was justified. There are *no* suppressed patents.

I am proud of our patent system, proud of its past record—a record which speaks for itself—and I sincerely believe that this record alone fully justifies its retention.

There will be attacks made on it in the future, as there have been in the past, probably by individuals who have little knowledge of their subject. It would seem that a comprehensive discussion of the exact situation at the time would be all that is needed to retain the merits of our present system.

Assuming that no disastrous changes are made in our patent system, certain trends in industrial research become obvious. Research has not yet come into its own with respect to many of the smaller units of industry. The larger units have been able, because of their position, to pioneer the general movements. This pioneer work was possibly too hazardous for the small units to undertake; but now that the exploratory stage is pretty well over and trained personnel is available for executive positions there is no longer any reason why the smaller units of industry should not make full use of industrial research for their own advancement and welfare. It may be argued that to be efficient a certain minimum-sized laboratory is needed and that small organizations cannot afford even this minimum size. There

is much in favor of such an argument; but a coöperative, or municipal, organization can overcome this difficulty. Such laboratories are coming into existence already.

I am of the opinion that, as time goes on, more and more research of the fundamental type will be necessary. This raises a serious question. Should such research be done in the actual industrial laboratory or would it be better, in most instances, to delegate it to the educational institutions? Admittedly, some special cases will occur wherein the fundamental knowledge will be needed so quickly that the higher tempo of the industrial laboratory, for obtaining results, will be indicated, and other cases will occur where the need for secrecy is so great that it cannot be entrusted elsewhere. However, the majority of cases should be such that they may be safely entrusted to the research staffs of our universities and colleges for study. This attitude should be encouraged whenever possible, for three reasons. First, the university staffs are generally able to bring a much broader vision to bear on these fundamental problems; second, where fundamental problems are being prosecuted in industrial laboratories they have a habit of being set to one side and forgotten when more urgent work develops; and third, the work thus given to the educational staffs will be of considerable value in educating future scientists to do more such work.

On the other hand, applied research should not be given to university or college staffs when the industrial unit is capable of performing this service for itself. Universities do not maintain the industrial tempo, nor are their staffs

in the habit of, nor should they be asked to, work in the confidential capacity required for successful patent control. Recently, many of our more technical schools have been developing a business department (usually called a foundation) for the purpose of successfully overcoming the above difficulties. It is sincerely to be hoped that such facilities will offer the small units of industry a means of solving many of their problems, both fundamental and applied.

Probably no other field holds more and varied promises for successful industrial research than chemistry: success for the investigator who may satisfy his curiosity about the unknown with a fair share of honor and wealth; success for industry which may increase its payroll, its output and its profits; and success for the public who will reap the benefits of better health, higher standards of living and a safer world in which to live and travel. There are two catches to this charming picture, of which I am aware. First is the recent apathy the public has shown toward raising its standard of living. It is discouraging to develop new things or to open the way to better comfort just to have the public yawn and say, "So what." Unless the public coöperates and raises its living standards as rapidly as industrial research makes it possible, unemployment is the inevitable result. I am not suggesting that the public go on a wasteful spending spree, ending up with little to show for it; but what I do mean is for the public to supply itself with better houses, better lighting, better radios and refrigerators, air conditioning and sound proofing, better automobiles, tires and gasoline, and the

thousand and one useful articles that industrial research will be improving again when the war is over. The second catch, or rather handicap, to immediate expansion of our industrial research is the lack of properly trained personnel in the chemical fields. The war has already eliminated three years of the normal supply of college graduates and if the upward surge of research takes place after the return of peace, which we all hope for, we will find ourselves very short of professional chemists and chemical engineers. There will almost certainly be a decided rise in salaries as competitive industry again gets under way. This will not be bad for the chemists and chemical engineers who are already in industrial work, but its repercussions on the educational situation may be quite disastrous. The universities are in no position to bid, financially, for the services of the younger men who are needed as instructors, later as assistant and associate professors and still later as full professors and heads of departments. Industry should take heed of this situation before it gets out of hand. By ample fellowships both in size and number it should encourage many young men to remain in educational work in order that its own full needs can be met in the near future.

A few years ago our fellow scientists in the field of astronomy presented our minds with the intriguing concept of an expanding universe. Although this concept explains the observed fact that lines of the spectrum shift toward the red in proportion to the distance from the earth of the spiral nebulae, it can scarcely be subjected to the rigid examination of the reproducible experiment,

and, hence, must be held as speculative until such an examination can be devised. However, in quite a different sense, our environmental universe is definitely expanding. Few discoveries of any importance are made that do not open up still greater fields for future investigation, and, consequently, more knowledge to be used by industrial research.

This accelerating expansion of potential fundamental knowledge constitutes an ever-growing stockpile of raw material ready for fabrication by industrial research. Obviously, this indicates a continuation of the expansion that industrial research has experienced during the past twenty-five years, irrespective of whether the "catching up" process is complete or not. It is difficult to develop any argument to contradict the desirability of expanding our industrial research in view of these realities; but there are other realities which will have a more quantitative effect than mere desirability. During the past twenty-five years industrial research has expanded ten times. Seventy thousand scientists are now engaged in it. Seventy thousand scientists is a rather large percentage of the total number available. Another sizeable group *must* remain in educational work, or the whole system will collapse. There is another group that will return with the armed forces which will be available after hostilities cease. However, it is doubtful if their number is much more than will be needed for replacement. Consequently, it is difficult to visualize any sizeable expansion until our supply of scientifically trained personnel can be increased through the normal process

of education. This will require at least a few years after the war ends; probably three or four.

Once expansion does set in, management will again be faced by the problems of organization, location and unit size of the new laboratories to be built.

The past twenty-five years has established certain concepts of research organization that we may expect to endure for some time to come. It is scarcely necessary to discuss these accepted principles at this time. The research "team" as a unit in this organization has gained popularity in the recent past. The individuals of any particular team are chosen for their qualifications in their field of specialization, as it is related to the problem to be studied. This is a different approach to organization than the conception of a departmental head, with a variety of assistants. Both unit types have their places. The "team" is better adapted to the solution of problems involving two or more fields of science, while the "head," with assistants, works best on problems less substantially confined to a single field. It has been observed that the problems involving multiple fields are becoming more numerous and hence the team conception is gaining in practice.

I have already mentioned that a minimum size of laboratory is indicated for retaining efficiency. It would be dogmatic to attempt to define such a minimum, since many variable factors are involved in making any particular determination. It is a statement of principle rather than a quantitative value that is implied. On the other hand it is fair to ask the question, "Is

there a maximum size, above which efficiency declines?" I have an instinctive feeling that there is. To make my point clear, it is necessary to define a laboratory as a group of research workers under the guidance of a single directing head. Obviously, a large building housing several such laboratories, with such things as library facilities, can be given a name and called a laboratory; but the unit size as above defined seems to me to have rather definite limitations. Again, this is a principle rather than a fixed value. The obviously controlling factor is the capacity of the research director to maintain an efficient understanding of the various problems for which he is responsible. In a way, this capacity is similar to a chess master playing simultaneous chess. Up to a certain number of games he is able to maintain a high playing standard; but, with a few more games added, the result is little more than a semi-automatic moving of pieces.

Another problem that eternally plagues management is location. There is no ideal location. There are advantages in being near the production center; there are advantages in being away from it. There is no advantage, that I am aware of, in complete isolation. No laboratory can be made so self-sufficient that it does not need services or supplies from the community wherein it operates. A laboratory operation located in a neighborhood lacking any such essentialities can only result in delay and inefficiency. With such isolation also comes an inadequacy of social contacts between the professional employees and others engaged in similar activities. The result

is deadening to the whole organization.

The problem of location with respect to the production center is familiar to most of you. There are undeniable advantages in having the laboratory personnel well informed with respect to production problems and economies. This can best be obtained by proximity. On the other hand, the proximity of the research laboratory to production is an ever-present temptation to the production management to draw the laboratory into undertaking or studying the daily "bread and butter" problems which the production unit should be capable of solving for itself.

I know of two extremes within the same industry, one going so far that it disperses its laboratories among its various production departments, while the other operates its research laboratories at an overnight trip from the plant. Seemingly, both operations are equally successful. Possibly the solution for maximum results can be obtained by having two laboratories; one at the plant and another a few hundred miles distant. Ultimately, the problems each is best adapted to solve will find their proper atmosphere.

Duplication of effort is another problem that faces most research executives. It is very noticeable following some strikingly new piece of fundamental knowledge. Witness the tremendous activity that followed the discovery of deuterium. Practically every department of chemistry was busily engaged in some form of deuterium research within a few weeks. Little more came out of this vast effort than would have resulted from a centralized research.

I believe it is the purpose of our patent system to stimulate competitive research on applied subjects. Yet, there are countless minor researches under way all the time in various laboratories that have no direct commercial value, that might very well be centralized, with excellent results and considerable savings. Call it "coöperative" or by any name you please, it should be encouraged. Duplication of effort is not always the result of competitive laboratories not knowing what the other is doing. Sometimes it occurs within the confines of a single laboratory and within the supervision of a single director. Sometimes it is accidental and sometimes the rapid solution of some critical problem is so necessary that management is justified in setting two or more groups at work on it at the same time. Usually it is well to have the different groups attack it from different viewpoints. It is a situation, however, that requires skillful management, or the result may be disastrous. As long as esprit de corps can be maintained with, perhaps, the stimulation of friendly competition, all is well; but once personal jealousies have developed stagnation rather than progress is likely to result. It is essentially a problem of personnel management.

I should like to close with the suggestion that better public relations be developed by industrial research in general. Many of the difficulties that

have been placed in the way of industrial research resulted from an ignorance on the part of the public and even of men in high places as to what it was all about. Ignorance breeds fear and fear motivates destruction. I am advocating that industrial research itself improve its public acceptance — not that industrial units merely advertise their own research departments. In fact this latter activity may be deleterious to the desired effect. Advertising copy has a way of romanticizing research, putting an air of mystery around the laboratory, calling it a "Home of Magic" or some other equally intriguing name. By these means the public is led to believe that industrial research is beyond their understanding, and what the public does not understand, it fears.

The public should be told just what research is when used by industry and how it benefits mankind. Then too, as little secrecy as possible should be placed around new fundamental knowledge. It must be recognized that lacking any legal means of protecting its use, except secrecy, that some secrecy is quite proper; but let it be as little as possible. Publish as soon as is compatible with safety and notify the public of this through the daily press, and keep in mind what Dr. Kettering once said, "When you lock the laboratory door, you lock out more than you lock in."

Flake calcium chloride added to coarse sand or screened cinders is recommended as a skidproofing mixture for winter icy roads; from 50 to 100 pounds of the chemical is used for each cubic foot of the abrasive.

Tannin making is one of Brazil's largest industries; quebracho is the raw material used.

Physicists Plan Unified Organization

► Physicists of the United States, during the past year, have had under discussion a plan for a central organization to weld together members of the profession for their mutual benefit.

Defining physics as "the science of energy and its transformations," and a physicist as "a man or woman with an insatiable enthusiasm for at least one branch of physics," the proposed organization would fill a need that has been felt by members of the five founding member societies of the American Institute of Physics. These founding members are the American Physical Society, the Optical Society of America, the Acoustical Society of America, the Society of Rheology and the American Association of Physics Teachers.

As reported by Prof. Richard M. Sutton of Haverford College to the Optical Society of America at a recent meeting, the trends of discussion have indicated a desire on the part of physicists (1) to maintain a high quality of scientific work and not to sacrifice fundamental research in the face of increasing calls upon their time to devote themselves solely to applications of past research; (2) to build up physics and other scientific training in the secondary schools for the safety of the country; to make college physics training meet the needs of the specialist and the non-specialist; to expand the present resources of graduate study to meet the demands after the war and to take care of training the needed

number of physicists; (3) to make the name "physicist" as well known as the name "chemist" and to keep it representative of the best in the profession; (4) to use all possible means to make the field of physics, its important contributions to human welfare, and the work of physicists known and understood by a greater portion of the populace. Interesting discussion has accompanied consideration of the question of federal finance and control of research, a matter likely to absorb much careful attention in the near future.

It is felt that the proposed organization should implement the aims of physicists, both scientific and professional, and should represent physics and physicists in their many relationships; it could, through a journal distributed to physicists generally, keep all advised of matters of common interest. Three meetings of the Policy Committee of the Governing Board of the American Institute of Physics have been held to explore this matter further. Particularly, the possibilities are being considered of opening the American Institute of Physics to *individual* membership, as well as to the present membership by its five Founder Societies. Membership in the Founder Societies would, perhaps, *ipso facto* convey membership in the central organization. Wider discussion of the issues involved is expected among interested persons until the details of a workable plan are prepared and adopted.

• A new chemical mixture has been developed which when applied to glass surfaces causes the shedding of all water during storms.

Rockets Replace Cannon On Mitchell Bombers

Waste Fats As Rocket Propellant

► THE AXIS WILL feel the blast of your waste kitchen fats in at least one new propellant that has been tailor-made for rockets. Developed by Army Ordnance in cooperation with the Hercules Powder Company, the new propellant gives rockets increased accuracy and makes them more effective. It comes in five-foot sticks, round or cross-shaped in cross-section. The new propellant contains nitroglycerin, instead of nitrocellulose, used heretofore. The propellant uses 50 per cent nitroglycerin, made from waste fats turned in by patriotic housewives.

Chief of the new rocket manufacturing problems is the propellant. This involves not only the propellant itself, which must possess certain qualities of stability through a wide temperature range and a desirable rate of burning, but also the problem of forming it into sizes and shapes suitable to mass production techniques. Few of the propellants used in rockets today were developed especially for rocket use. In most cases they are modified forms of other propellants and were developed rapidly to meet the urgent need for combat tactics.

Rockets have proved one of our most successful war weapons in the 11 months that the Army Air Forces have been using them in the China-Burma-India theater and in Western Europe against trucks and tanks, troop concentrations, radio stations, storage depots, shipping and railways.

Many problems connected with the manufacture and tactical use of rockets are still far from being solved. What is true today of range, accuracy, and battlefield use will probably not be true tomorrow. New developments in rockets are almost continuous. Launchers, which consist of nothing but rails, tubes or slides fitted with electrical ignition attachments, may now be made of plastic, saving tons of vital metal for other war uses. These launchers have none of the complicated recoil devices and heavy breech mechanisms of standard artillery.

The four tactical uses of rockets are: air-to-air, in which planes launch rockets at other planes; air-to-ground, in which planes use rockets against fortifications and personnel; ground-to-air, the anti-aircraft use of rockets; and ground-to-ground, including such equipment as the bazooka and the M12 artillery rocket launcher. Rocket development in the United States by the National Defense Research Committee, Army Ordnance, Navy Department and Office of Scientific Research and Development, has been aimed primarily at air-to-ground and ground-to-ground use. The Germans have tried air-to-air rockets against our bombing formations, but without much success.

In the Army Air Forces our B-25 Mitchell bombers now have rocket tubes, replacing the 75-millimeter cannon; P-40 Warhawks, P-38 Lightnings, P-39 Airacobras, P-47 Thunderbolts, and P-51 Mustangs have been fitted

with rockets slung under the wings in three-tube clusters, using 4.5-inch M8 projectiles with M10 or M14 launchers. In Burma, AAF pilots combine rocket fire with bombing. In Europe, Nazi troops are strafed heavily by rocket-firing Allied aircraft. Aircraft rockets permit fighters, light bombers, and attack planes to hurl greater concentrations of fire than their own cannon or machine guns and with greater accuracy than the equivalent weight of free-falling bombs.

The main advantage of air-to-ground rockets is that there is no recoil to interfere with the smooth performance of the airplane, permitting it to get in fast and get away fast. More explosive can be put into the target with rockets than with air artillery.

The first rocket to be fired from an AAF plane was launched in the Southwest Pacific theater last March.

According to rocket researchers, the greatest need today in rockets is for better sighting equipment to improve

accuracy. Perhaps an automatic computing device similar to the electronic bombsight now in use would be the answer. Such a device would have to be simple enough for a single fighter pilot to use without taking too much attention away from his flying. It should inform the pilot of the exact point at which he should release his rockets to hit his target, taking into consideration air speed, wind velocity, wind direction, the altitude of the plane, and other important factors.

Improved sighting devices will also have to be developed for air-to-air use of rockets, if in the future we should decide to knock out such planes as the Japs' "Emily," which is like our B-25 but faster and equipped with 20-millimeter cannon all around. It is difficult to shoot the Emily down today, since our planes cannot get close enough to put shells into her without running the risk of being hit by her guns. She could, however, be shot down with rockets launched beyond the 1,800-foot effective range of her guns.

Achievements in Synthetic Chemistry

► AIR, WATER, COAL, oil, gas, salt, lime—raw and plentiful materials of earth are metamorphosed by the modern chemist into an array of new stuffs superior to the old in strength, durability and beauty.

Strands for stockings and parachutes no silkworm could ever make. Plastic threads resistant to weather. Organic "glass" that does not break. Tough new resins for autos, houses, factories. New uses for the grandfather of plastics made from two disinfectants, for-

maldehyde and carbolic acid.

Synthetic resins for our plastic world. Molecules expertly rebuilt by master chemists, cheap materials made more valuable because more useful.

Synthetic rubbers to make our tires when war-made tree-grown rubber scarce. Chemical rubbers that have properties better than the natural kind.

Such is chemistry's creative artistry.

—Watson Davis in a National Education Association Personal Growth Pamphlet.

The syrup made from sweet sorghum contains twice as much iron as sugar cane molasses.

New Field Opening For Trained Men

Electronics Isn't All Radio

► **INDUSTRIAL ELECTRONICS** is a broad field, now important because of the needs of the war, in which there is a lusty future for the men who will study it seriously and do their part in helping build it up. This is the opinion of W. D. Cockrell of the General Electric Company given at the meeting of the Institute of Radio Engineers held in New York City recently. He pointed out some of the differences between radio electronics as used in the communication field and industrial electronics used in manufacturing plants.

"Industrial electronics," he said, "is definitely a member of the electronic family. Its essential elements are vacuum- or gas-filled tubes through which electrons flow. But the practical technique of operation, the personnel who must install, operate, and service it, and the economics which govern its design and construction will be found to vary somewhat widely from that found in the communication field."

Three Classes of Equipment

Three classes of electronic equipment are used in American industries, he stated. One includes industrial amplifiers and oscillator units such as those used in high-frequency induction and dielectric heating, elevator leveling equipment, diathermy equipment, metal detection, and in scientific instruments employed in the plant.

Small control devices, such as the electric eye, photoelectric relays, timers, and contact amplifiers employing

only one or two tubes, are a second class. Power conversion equipment is the third. This is the large power-conversion equipment, such as the ignitron and tank type mercury arc rectifiers, inverters, and frequency changers. In communication electronics, from ship to ship or from the ground to airplanes for instance, installation men and operators must have extensive training as lives and cargoes depend upon their work. For industrial electronics less extensive training is required.

Disk-Seal Tube

Several factors which limit the operation of grid-controlled tubes were discussed at the same meeting by E. D. McArthur of the same company. Starting with these problems, he described how a new disk-sealed tube used in conjunction with cavity resonators alleviates many of these problems so that very much higher operating frequencies can be obtained.

He showed the detailed structure of several typical disk tubes and an example of the grid-separation type resonant cavity oscillator. Only a limited amount of operating data were given, due to the need of military secrecy.

At the same meeting, R. L. Kelly and N. H. Green, Radio Corporation of America, discussed the development of small tubes for use in receiving sets by the Army and Navy. Requirements were excellent ultra-high-frequency

performance, adequate mechanical strength, and minimum effects due to climatic variations. The miniature type of tube developed, heater-cathode tubes, meet the requirements. The

high-frequency performance, they stated, is exceptionally good because of the low-inductance leads and because of the stability provided by all-glass bases.



Cartoon by Lichty—Chicago Times Syndicate

"We thank Thee, for the abundance of vitamins A to K, riboflavin, minerals—we now beseech Thee for more butter, chocolate syrup and cigarettes."

Chem Quiz

Old Salts

► OLD NAMES for many chemical compounds are still current here and there. The salts whose names are listed in the first column have their formulas listed

in the second, in different order. They are identified on page 51. Score 4 points for each pair you matched correctly. Yes, there is one duplication.

- | | |
|--------------------------|---|
| 1. Blue vitriol | (a) HgCl |
| 2. Calomel | (b) $3\text{CuOAs}_2\text{O}_3 \cdot \text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$ |
| 3. Chloride of lime | (c) ZnO |
| 4. Copperas | (d) ZnSO_4 |
| 5. Cream of Tartar | (e) CuSO_4 |
| 6. Epsom salts | (f) FeSO_4 |
| 7. Flowers of zinc | (g) As_2O_3 |
| 8. Green vitriol | (h) $\text{Ca}(\text{ClO})_2 \cdot 4\text{H}_2\text{O}$ |
| 9. Hypo | (i) $\text{Ca}(\text{OH})_2$ |
| 10. Litharge | (j) HgNH_2Cl |
| 11. Liver of sulfur | (k) NH_4Cl |
| 12. Lunar caustic | (l) $\text{KHC}_4\text{H}_4\text{O}_6$ |
| 13. Microcosmic salt | (m) KNO_3 |
| 14. Paris green | (n) K_2S |
| 15. Powder of succession | (o) Na_2SO_4 |
| 16. Prussian blue | (p) Na_2CO_3 |
| 17. Red lead | (q) $\text{NaNH}_4\text{HPO}_4 \cdot 4\text{H}_2\text{O}$ |
| 18. Sal ammoniac | (r) $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ |
| 19. Sal mirabilis | (s) $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$ |
| 20. Sal soda | (t) PbO |
| 21. Salt of wisdom | (u) Pb_3O_4 |
| 22. Saltpeter | (v) $\text{Fe}_4(\text{Fe}(\text{CN})_6)_3$ |
| 23. Slaked lime | (w) AgNO_3 |
| 24. Sugar of lead | (x) MgSO_4 |
| 25. White vitriol | |

Health Often Linked to Diet

by JANE STAFFORD

With food rationing becoming more of a problem, these latest reports from the medico-chemical food front as told by Science Service's medical writer will find use in home and kitchen.

Soybeans and Protein

➤ REMEMBER soybeans and soya flour if you are having trouble stretching your meat ration. Those of you who grew them in Victory gardens last year are undoubtedly thankful to have cans of them on the pantry shelf now.

Soybeans rank as "tops in protein, fat, iron and calcium," U. S. Department of Agriculture scientists have often pointed out. Tests show them to be almost twice as rich in protein as green peas or fresh limas. It is this protein richness that makes soybeans something to choose for the main course of a meatless meal. The digestibility of soybean protein rates at about 90 when compared with egg protein rating 100, and the biologic value is better than 90. Commenting on the studies from which these figures come, the Journal of the American Medical Association observes that soybeans can be considered as excellent source of protein for nourishing grown persons.

Besides their protein richness, soybeans have another characteristic that makes them valuable for wartime meals. This is their high fat content in which they are more than seven times as rich as lima beans and 11

times as rich as green peas. This means they can be served with less butter or other fat than other garden beans or peas.

Soybeans are a good source of three B vitamins, thiamin, riboflavin and niacin, and they furnish calcium, phosphorus, iron and other minerals. Soybean sprouts are rich in vitamin C and the fresh beans, though not the dried ones, contain a goodly quantity of carotene, the yellow plant chemical that the body turns into vitamin A.

Besides the beans themselves, which can be prepared in as many dishes as other kinds of beans, the soya flour can be used in home baking to add nourishment to baked foods, pancakes and the like.

Health from Enriched Bread

➤ ENRICHED BREAD, which most of us have been eating every day for two years, is in the news again. At present, enrichment of all baker's white bread and white rolls is required by a War Food Order. After the war, bread enrichment will not be compulsory unless state legislatures make it so. A federal law would affect only bread handled in interstate commerce. Some states have already adopted such legislation and others are considering it.

The present enrichment of bread consists in the addition of three B vitamins and iron. The vitamins are thiamin, niacin and riboflavin. Scientists

surveying the average American diet found that before the enrichment of bread the average diet furnished less of these vitamins and iron than are recommended for best health.

The best way of making up this deficiency seemed to be the enrichment of white flour and bread which almost everyone eats in significant amounts and which is eaten in large amounts by the low income groups whose diets are most likely to be deficient. The facts that bread could be enriched at a low cost without changing its appearance or taste and that the enrichment consisted in replacement of substances removed by the processing of fine white flour were additional reasons for it.

Because of the health benefits, our present bread enrichment should continue, in the opinion of scientists such as members of the food and nutrition board of the National Research Council, the council on foods and nutrition of the American Medical Association and members of the American Public Health Association. In an editorial urging that bread enrichment be continued, the Journal of the American Medical Association calls attention to a report of a decrease in cases of florid pellagra and beriberi when bread enrichment was still only on a voluntary basis. The benefits to much larger numbers of persons suffering from milder chronic degrees of these deficiency states, the editorial points out, will probably be the greatest contribution of enrichment.

Invalid Diets Improved

► THE TRADITIONAL invalid diet against which many a patient has protested in the past may soon be changed. Cus-

tards, soups, soft-cooked eggs and other liquid or semi-solid foods may give way to or be augmented by ground meat and other solid food and ice cream. The quantities of milk and water may be reduced.

All these changes will reflect a new medical viewpoint which stresses the importance of nutrition during illness and convalescence. Sulfa drugs and penicillin have something to do with the change. With these powerful medicines for successfully fighting germ invasion of the body, doctors can give more attention to other aspects of recovery and they are finding how it can be hastened by proper feeding.

The liquid, semi-solid and soft diets for patients recovering from illness or operations "may be arbitrary and unjustified and require reconsideration and revision," the editor of Nutrition Reviews states in reporting the findings of a committee of the National Research Council.

As an example of the need to give more attention to the nourishment of patients is the case of a 21-year-old Marine who sustained a gunshot wound through the left side of his chest. Although he was seriously ill for a time, he recovered completely. However, when he was permitted to walk after three weeks, it was found that he had lost 37 pounds in weight.

When a person is undernourished, it is pointed out, he loses his appetite and this leads to greater malnutrition. So the committee urges attention to the nutrition of patients at the very start of their illness. Making the diet more palatable will help in many cases. Some patients are afraid to eat after an operation and need reassurance from their

doctors. Others may need specific direction from the doctor about eating.

Drug Checks Appetite

► A DRUG which can be used to help overweight people reduce by checking their appetite is described by Dr. Harry Gold, of Cornell University Medical College in a report to the American Chemical Society. The drug is amphetamine, also called benzedrine and best known, perhaps, for its ability to banish fatigue and promote wakefulness. It has been used in treating a number of disorders, sometimes in combination with other medicines. Speaking of its use in reducing weight, Dr. Gold says: "There is still another cause of ill health in the control of which amphetamine has been extensively applied, a condition which in those over 40 reduces to almost half the chance of surviving the age of 60. I refer to its use as an adjunct to other measures in the treatment of obesity. The drug impairs the appetite. The subject with an other-

wise voracious appetite seems to lose interest in food.

"This effect is often referred to as an action on the gastrointestinal tract and is explained on the basis of diminished hunger contractions. It seems more likely, however, that its psychological action is the main factor. Obesity is frequently a state of mind.

"People often take to eating when they are unhappy for the purpose of release from states of depression and tension. The habit of overeating acquired in this way has a firm hold on its victim and is not easily cured except with the aid of psychological measures. The actions of amphetamine on the mind are pre-eminently suited for the purpose."

The drug should not be taken without the advice of a physician. Some persons are not helped by it, some react differently to it at different times, and the necessary dosage is uncertain and differs from time to time in the same person, Dr. Gold warns. Its action, moreover, is only temporary.

Colchicine Applied By Aerosol Method

► COLCHICINE, the drug that changes the hereditary characters of plants by increasing the number of chromosomes per cell, can be applied effectively to scores or hundreds of young plants at a time by the aerosol method, originally used with insecticides to make wholesale kills of winged pests. Use of colchicine as an aerosol was developed by three U.S. Department of Agriculture research scientists, J. W. McKay, P. C. Burrell and L. D. Goodhue, at the great experiment station at Beltsville, Md.

Greatest effect in changing the gene-

tic makeup was obtained when the dose was most drastic, the three researchers state. They got highest percentages of change among survivors of blocks of young plants after aerosol-spray treatments that killed most of the seedlings with which they started out.

They also suggest that better penetration of the colchicine, and hence most effective use, may be obtained by mixing into the solution some mildly poisonous chemical that will lower the resistance of growing tissues to penetration.

Life-Chemistry Genetics Problems

► CHEMISTRY has come to the aid of biology in solving some of the more difficult questions of how parental characters are passed on to offspring—and of how these characters sometimes change, giving rise to new evolutionary lines or pinching off old ones.

Specifically, it is biochemistry that is thus helping forward the study of genetics, Prof. G. W. Beadle of Stanford University declared recently in a lecture given under the auspices of the Society of Sigma Xi at the University of Oregon. This was the first of a series of national Sigma Xi lectures by Prof. Beadle at various universities throughout the nation.

Earliest studies in genetics, like the classic researches of Mendel, concerned themselves with easily visible differences in organisms, such as color of flowers or seeds in plants, shape of wings or kind of hair in animals. A great deal of profitable work is still being done along those lines.

However, plants and animals also have definite modes of inheritance in their invisible internal chemical reactions. What they do with their food, how they build it into their body substance, how they may sicken and die for lack of an indispensable hormone or vitamin, are as definitely con-

trolled by their genes as are color, shape or size of body parts. These intricate reactions in life-chemistry are the present subjects of research by Prof. Beadle and his associates at Stanford University, and of other investigators elsewhere.

The special organism chosen by Prof. Beadle is a species of red bread mold, which makes a very desirable vegetable guinea-pig for a number of reasons, outstanding among which are the ease with which it responds to breeding techniques and the sharpness of the differences its new strains show in their biochemical reactions.

The mold is induced to undergo gene changes by bombarding it with X-rays, ultraviolet radiation or neutrons. Sometimes a gene drops out of its makeup. In some of these cases, the result is a new strain of mold that cannot put together the simpler compounds in its food medium to make some necessary item in an organism's life-equipment—vitamin B₁ for example.

Ordinarily, of course, such a deficient strain would die, but by artificially supplying the lacking food element it is possible to keep it alive and to continue studies on its hereditary behavior.

When gasoline becomes plentiful again and makeshift motor fuels are pushed aside, scientific and experimental interest in the substitutes will remain, looking forward to future developments in economy and efficient engine operation.

Silicates in laundry soaps are in common use and some soaps contain as much as from 10% to 30% of these chemicals.

Periodic Table of

	GROUP O	GROUP I	GROUP II	GROUP III	GROUP IV
		1 Hydrogen H 1.008			
Series 1	2 Helium He 4.003	3 Lithium Li 6.940	4 Beryllium Be 9.02	5 Boron B 10.82	6 Carbon C 12.010
Series 2	10 Neon Ne 20.183	11 Sodium Na 22.997	12 Mag- nesium Mg 24.32	13 Alumi- num Al 26.97	14 Silicon Si 28.36
Series 3	18 Argon A 39.944	19 Potassium K 39.096	20 Calcium Ca 40.08	21 Scandium Sc 45.10	22 Titanium Ti 47.90
		29 Copper Cu 63.57	30 Zinc Zn 65.38	31 Gallium Ga 69.72	32 Ger- manium Ge 72.60
Series 4	36 Krypton Kr 83.7	37 Rubidium Rb 85.48	38 Strontium Sr 87.63	39 Yttrium Y 88.92	40 Zirconium Zr 91.22
		47 Silver Ag 107.88	48 Cad- mium Cd 112.41	49 Indium In 114.76	50 Tin Sn 118.70
Series 5	54 Xenon Xe 131.3	55 Cesium Cs 132.91	56 Barium Ba 137.36	57 Lan- thanum La 138.92	
				58 Cerium Ce 140.13	
				59 Praseo- dymium Pr 140.92	
				60 Neody- mium Nd 144.27	
				61 Illinium II 146?	
				62 Samarium Sm 150.43	
				63 Europium Eu 152	
				64 Gadoli- nium Gd 156.9	
				65 Terbium Tb 159.2	
				66 Dyspro- sium Dy 162.46	
				67 Holmium Ho 164.94	
				68 Erbium Er 167.2	
				69 Thulium Tm 169.4	
				70 Ytterbium Yb 173.04	
				71 Lutecium Lu 174.99	
				72 Hafnium Hf 178.6	
		79 Gold Au 197.2	80 Mer- cury Hg 200.61	81 Thal- ium Tl 204.39	82 Lead Pb 207.21
Series 6	86 Radon Rn 222	87 Virginium Vi 224?	88 Radium Ra 226.05	89 Actinium Ac 227	90 Thorium Th 232.12

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MISTRY

Elements and Their Chemical Properties

by HELEN M. DAVIS

FOURTH in a series of articles that take the reader along the pathways of basic chemistry, by easy stages.

► THE CHEMIST finds the Periodic Table an indispensable tool because it groups together the myriad different properties of the ninety-two or more elements in a scheme that is easily remembered. Fundamentally, it is just the list of the elements arranged in order of their atomic weights, or numbers. Hydrogen, having somewhat special properties, occupies a place by itself at the top of the Table.

The next eight elements, from helium to fluorine, show a steady progression from one type of behavior to quite an opposite type. The properties of these elements set the pattern for the arrangement of the rest of the Table. It has been found most convenient to write them in a horizontal line, usually referred to as Series 1, also called the First Short Period.

Each of the eight elements in this line heads a vertical column into which fall, in their natural order, other elements whose properties are similar. These vertical columns are universally referred to as Groups, and numbered from left to right. They begin with Group 0 in which occur the inert gases which form no chemical compounds

and hence have a valence of 0. Lithium, element number 3, falls in Group I, the group of active metals called the alkalis which react with water to form caustic bases, displaying a valence of 1.

Lithium, however, does not head Group I. Hydrogen has a valence of 1 and, although it forms no caustic bases, it can replace one atom of an alkali metal in a salt to form another salt of very similar properties—witness Na_2CO_3 washing soda, NaHCO_3 baking soda—so hydrogen is put at the head of Group I.

The metals of Group II are less active, less basic, have a valence of 2. Their oxides, relatively stable even in moist air, have a white, earthy appearance which long ago gave the group the name of alkaline earth metals.

Group III elements have a valence of 3. They form hydroxides which are not at all caustic. Boron, the first member, even forms an acid, though surely boric acid is the mildest of the compounds that go by that name. Group III is famous for containing the puzzling set of Rare Earth elements, fifteen whose compounds are so similar in habit that it is a notable exercise in patience to separate them one from another.

With Group IV the middle of the Table is reached, and the most remarkable element of them all, carbon,

without which we would not be here studying about the rest of them. In harmony with its group number, carbon has a valence of four. It shows ability to combine with other atoms of the same kind to a far greater degree than any other element. Leaving this type of compound for further study under the name of organic chemistry, we find carbon in combination with other elements acting as an acid-forming element. Calcium carbonate, CaCO_3 , as limestone makes up a large part of the crust of the earth. Carbonic acid itself is a mild compound which breaks up at ordinary temperatures and pressures into water and carbon dioxide, as in soda water.

With Group V the definitely negative, acid-forming elements are reached. Nitrogen is really a rather inactive element, with a little of carbon's preference for combining with other atoms of its own kind. Its terrible power as an explosive comes rather from its haste to get away from other elements than from its avidity to combine with them. Nitrogen is the first element in Series 1 to display two valences. It makes a complete set of nitrous compounds and nitrites with a valence of 3 and of nitric compounds and nitrates with a valence of 5.

Oxygen in Group VI is perhaps the element with which we are most familiar, since we are constantly breathing it. Most metals combine with it sooner or later, and it nearly always exhibits a valence of two. Many of the heavier metals when combined with oxygen form salts as though they were acids, and the non-metals nitrogen and sulfur combine with oxygen to form powerful acids with corrosive properties. On this account, oxygen was at

first thought to be the necessary constituent of all acids, and its name means "acid former."

Partly because it was thought that the sum of the oxides would represent the constitution of any compound, and partly because in analysis the metals were precipitated and weighed as oxides, it used to be customary to express chemical formulae as a string of oxides. This practice is still commonly followed in giving the analyses of minerals.

Group VII begins with fluorine, lightest of the halogens, the salt-formers. The halogens have a valence of one, are the most negative elements, and combine directly with hydrogen to form acids.

Series 2 of the table furnishes eight elements which match those of Series 1 in characteristic properties. These two lines are known as the two short periods. Series 3 starts out with elements fitting into the Groups begun by elements of the short periods, but when the middle of the Table has been reached the properties of the Series 3 elements are found to be diverging more and more from the types set by their lighter analogues. While calcium is quite similar to magnesium, scandium is less like aluminum and titanium is scarcely at all like silicon. A long row of metals now intervenes in the order of the series, which takes up two lines in the usual arrangement of the Table, until germanium is reached in the second line in Group IV. Germanium forms chains of compounds with itself in somewhat the same way that carbon and silicon do. Arsenic is more than a little like phosphorus. Selenium is a very close relative of

sulfur, and bromine is an unmistakable member of the halogen family. Thus Series 3 returns to conformity with the pattern of the Table, and the first long period is ended.

The reason for writing the elements of the long periods in the pattern of the short periods is that the valences match those of the other elements in the Groups, even though the types of compounds they form differ.

Series 4, beginning with krypton and ending with iodine, has an element to match every one in the preceding long period, even including the triplets which make up Group VIII.

Series 5 starts out like all the other periods of the Table, and then throws in a new surprise in Group III with the 15 elements known as the rare earths. Most arrangements of the Periodic Table print the first one or two of the rare earths, and put the rest in a footnote. CHEMISTRY this month, on pages 32-33, prints its own version of the Table with all 15 rare earths in place, just to show how many of the pesky things there are. One's first impulse is to say, "I don't believe it," but for that very reason a great many people have studied them. They are all real elements, with as much individuality as other elements have, but they all seem to belong in one Group. After so long a pause, the rhythm of the periodic arrangement picks up again with hafnium, undoubted analogue of zirconium, and completes the third long period, including such old favorites as gold, mercury, lead and bismuth.

But if the other series have their quota of surprises, Series 6 is packed

with glamour, drama and mystery. Radioactivity, isotopes, transmutation belong to this unfinished symphony. What lies beyond? It is easy to extrapolate to a certain extent. We are practically certain that element 85 is the last of the halogens, 87 the most positive of the alkali metals. Number 93, of which there is some evidence, will be a metal something like rhenium. Next we should expect an eighth group triplet, 94, 95, 96, then 97, the radioactive analogue of gold! Will the rare earth complex be duplicated in Series 6, or will some other horrid surprise greet the explorer who finds these fabulous elements? There are more profitable fields of chemical endeavor.

Those who would like to pursue further the amazing ramifications of the isotopes are referred to the leading article in *Reviews of Modern Physics*, Vol. 16, No. 1, January, 1944, "Table of Isotopes," by Glenn T. Seaborg of the University of California. Dr Seaborg has assembled data and references on all the isotopes of all the elements (some elements have a dozen).

As a generalization of trends in the properties of the elements, we may say that the elements change from positive at the left-hand side of the Table to negative at the ends of the periods and that in going from top to bottom in any group the elements become more positive and more metallic. The traditional rule is that the properties of any element are the mean of the properties of its analogues—the elements immediately preceding and following it—in both group and series. This is a rough and ready way to identify the properties of any element.

New Patents in Chemical Field

Week by week as the Patent Office Gazette officially announces the new patents granted, there are many that are important to the science and technology of chemistry. For information about any patent you may obtain the complete patent by sending 10 cents in coin (not stamps) to the Commissioner of Patents, Washington, D. C., and asking for the patent you wish by number.

De-Leading Gasoline

► **DE-LEADING** leaded gasoline is something soldiers very much want to do, when they need field-stove fuel or cleaning fluid and only ethyl gasoline is available. To accomplish this, F. E. Neef, Jr., of Detroit, has invented a process on which he has received patent 2,368,261. Rights to manufacture and use are assigned, royalty-free, to the government.

The process is quite simple. It consists merely in filtering the gasoline through a column of fine-grained clay (bentonite) which has been activated either by heating or by treatment with hydrochloric or sulfuric acid. The inventor states that the action is not a simple physical filtering one, but that there is a chemical reaction between the dissolved chemical and the activated clay.

New Aluminum Brasses

► **A PROCESS** for making brass alloys containing aluminum, in addition to the traditional copper and zinc, is the

subject of patent 2,368,339, obtained by M. L. Wood of Waterbury, Conn., and assigned by him to the Chase Brass & Copper Company, Inc., of the same city.

Incorporation of a small percentage of aluminum in brass is desirable, Mr. Wood states, because it permits the metal to withstand severe distortion without developing defects. A difficulty in making such alloys lies in the presence of small particles of aluminum oxide. In the new process, this oxide is reduced by conducting the melting in a closed induction furnace, under an atmosphere of hydrogen or a hydrocarbon gas. This reduces the oxide, leaving pure aluminum in the metal.

Aluminum-Loaded Rubber

► **ALUMINUM** is introduced into rubber tubing and other articles subject to deteriorating heat, as a means of lengthening the life of the rubber, in the process on which patent 2,368,190 was issued to R. E. Wood of Downers Grove, Ill. The aluminum is worked into the pores of sponge rubber in the form of a fine metal powder, about 10 parts by weight of aluminum to 50 of rubber going into the mixture.

Sintered Structures

► **MAKING THIN-WALLED** articles out of sintered metal, carbide, etc., is the contribution to technology on which E. W. Engle of Huntington Woods, Mich., claims patent 2,368,458. Hitherto, sintered articles have been made by mold-

ing the metal or carbide powder in relatively thick masses, then heating. In Mr. Engle's new process, the powder is mixed into a thin paste with oil, the paste spread evenly on the mold, and the sintering process then completed by heat.

Rights in the patent are assigned to the Carboloy Company, of Detroit.

Lava for Magnesium Fires

➤ LAVA POWDER, the ash of earth's natural furnaces, is the means used for putting out flaming magnesium bombs, in the method on which patent 2,368,209 was granted to J. J. Fahey and Michael Fleischer of Washington, D. C., and W. W. Rubey of Westmoreland Hills, Md. Rights in their patent are assigned royalty-free to the government. Volcanic ash and tuffs are ground to a fineness that will permit passage through a screen not smaller than 200 mesh. No other treatment is necessary; the powder is merely shoveled onto the burning magnesium, and the fire is smothered.

"Mercy Bullets"

➤ A QUICK-KILLING poison charge. to be fired into the snarling mouths of trapped coyotes or other predatory animals, is covered by patent 2,368,368, issued to Ethel P. Marlman of Las Animas, Colo. Potassium cyanide is mixed into a soft paste with petroleum jelly and loaded into shotgun shells. The charge is, of course, to be used at short range.

Strips Leaves

➤ CHEMICAL sprays that strip the leaves off trees and other plants, without further injuring them, are the basis of several patents, Nos. 2,368,274 to 2,368,276 inclusive and No. 2,368,601,

all taken out by Robert E. Torley of Greenwich, Conn., assignor to the American Cyanamid Company. Sodium fluoride and ammonia are among the compounds used. Defoliating trees and shrubs is sometimes desirable, the inventor explains; for example, in hastening the ripening of fruit, and sometimes in combating insect pests by depriving them of their food.

Gas Auto Fuel

➤ "BOTTLED GAS," now widely sold in cylinders for kitchen purposes in areas beyond the reach of city gas mains, is made available for use in internal combustion engines, both automotive and stationary, through an adapter on which U. S. patent 2,368,680 has just been issued here, to John Riise of Doylestown, Ohio.

This fuel consists of a mixture of butane, propane and other light hydrocarbons that are gases under ordinary conditions but readily liquefy under pressure. This makes their handling in cylinders easy and economical. Mr. Riise re-converts the liquid fuel into a gas by warming it in a water-jacketed cylinder around which water from the engine's cooling system circulates. In place of the carburetor he uses a special mixing valve, to add the correct proportion of air.

New Peroxide Method

➤ THERE IS a new way to make hydrogen peroxide—a compound of even greater importance in industry than it is in the theater district. Dr. Gerhard A. Cook of Snyder, N. Y., makes it directly from oxygen and hydrogen gases by putting a properly proportioned mixture through enamel-lined tubes with very smooth walls at a

temperature of around 520 degrees Centigrade, at moderately high pressures. On this process he has received patent 2,368,640, rights in which are assigned to the Carbide and Carbon Chemicals Corporation.

Un-Sticking Wheat Starch

► FOR A NEW process for making wheat starch, two U. S. Department of Agriculture chemists, Dr. C. T. Langford and R. L. Slotter, of the Northern Regional Research Laboratory at Peoria, Ill., have been granted patent 2,368,668. Wheat starch has always been troublesome to manufacture because the principal wheat protein, gluten, swells up when wet and forms a sticky, doughy mass, very hard to get rid of. The two chemists have overcome this tendency by adding sulfur dioxide to the processing water. This forms a weak solution of sulfurous acid, which takes the stickiness out of the gluten and releases the starch grains from its grip. Rights in the patent have been assigned royalty-free to the government.

Casein Curds Floated Out

► FOR AN IMPROVEMENT in the method of extracting casein, milk's principal protein, E. L. Fritzberg of Minneapolis has been granted patent 2,368,919, which he has assigned to General Mills, Inc.

The conventional way of getting casein out of milk involves adding acid, which produces heavy curds that sink to the bottom. Subsequent handling renders the casein unfit for human food, so that it has to be diverted to lower-priced industrial uses. In Mr. Fritzberg's method, carbon dioxide or some other gas is introduced

into the milk during the acidulating process, which results in the formation of bubbly curds that float to the top and can be mechanically skimmed off in cleaner condition, suitable for eventual incorporation into food products.

Fermented Grass

► NEBUCHADNEZZAR took his grass straight, like a cow; we moderns may get it as an amber-colored drink. Pat. 2,369,042, issued to W. R. Graham, Jr., and C. W. McCarty of Kansas City, Kans., covers a process for making a dark beverage out of grass or sprouted grain foliage that has been wilted and slightly crushed to release the digestive enzymes, then permitted to ferment naturally for anywhere from three hours to three days. Dried for storage and shipment, the product may be soaked in water to produce the beverage whenever desired. Patent rights are assigned to American Dairies, Inc., and the Quaker Oats Company.

Defluorinating Phosphate

► GETTING UNDESIRABLE fluorine out of phosphate rock intended for fertilizer is the subject of patent 2,368,649, obtained by Dr. K. L. Elmore of Sheffield, Ala. The process consists in heating the rock to about 1,500 degrees Centigrade and running steam through it to extract the fluorine. Patent rights are assigned royalty-free to the government, through the Tennessee Valley Authority.

Tool Steel

► HARDER TOOL STEEL, for faster production of the wares of war and more efficient reconversion to the works of peace, is promised in patent No. 2,369,211, issued to F. H. Clark of New York City and R. F. Dirkes of Jamaica, N. Y.

Their process is a variant of the now familiar sintering method, wherein metallic powders are molded into the desired form and then heated until they become solid. The Clark-Dirkes steels are made by mixing into powdered iron or steel an excess of powdered carbides of tungsten, vanadium or other hardening alloy metal. When the sintering heat is applied, part of the hardening material blends with the iron, and the rest of the diamond-like particles remain unchanged, firmly embedded and bonded into the mass of the steel.

Fluffier Mineral Wool

► **FLUFFIER** mineral wool, free from unfibred lumps, is delivered by a machine on which E. R. Powell of North Plainfield, N. J., received patent 2,369,605. The molten slag, glass or other material from which the mineral wool is to be made trickles from a spout. A blast of air or steam strikes it, blowing it into long, fine strands; but mixed with these are solid little beads of hardened material, undesirable in the product. The light fibers are blown over the top of a slowly rotating drum, while the heavier beads strike and stick to it. Carried down underneath, they are scraped off and fall into a hopper. Rights in the patent are assigned to the Johns-Manville Corporation.

Mercury Vapor Lamp

► A **MERCURY VAPOR LAMP** no bulkier than an ordinary incandescent bulb is covered by patent 2,369,591, rights in which have been assigned to the Westinghouse Electric & Manufacturing Company by the inventors, John W. Marden of East Orange, N. J., and George Meister of Newark.

Mercury vapor is a more desirable filling for lamps than nitrogen or other inert gas because of its lower heat conductivity, the inventors point out; but hitherto it has not been used because of the destructively high filament temperatures required while the mercury was being vaporized. They get around this difficulty by the very simple device of using both: inert gas to protect the filament during the warming-up period, and mercury to increase efficiency once the lamp is in full operation.

Vitamin A

► **ON ONE GROUP** of related chemical processes, the manufacture of vitamin A and its compounds, no less than 13 patents, Nos. 2,369,156 to 2,369,168 inclusive, were granted to Nicholas A. Milas of Belmont, Mass., assignor to the Research Corporation, of New York.

"Canned" in Plastic

► **CANNING FOODS** in flexible plastic bags instead of the conventional rigid containers of tinned metal or glass is the invention that won patent 2,369,765 for H. F. Waters of New York City. The food to be preserved is poured into the bag and heat-processed with the top wide open. Then the top is closed and clamped or sealed tightly while hot vapor is still rising from it. When the package is cooled the vapor condenses, collapsing the top of the bag upon the upper surface of the food. An outer carton is added, for greater security and attractiveness in marketing.

Face-Hardening Steel

► A **SPECIAL STEEL** for face-hardening to very shallow depths, suitable for such purposes as thin armor plate and

small cutting tools is something new. It is made by adding very small quantities of arsenic and aluminum to the conventional carbon-steel mix. Janet Z. Briggs of New York City received patent 2,369,656 on this invention.

New Abrasive

► A NEW ABRASIVE or grinding material incorporating titanium and an oxide of either vanadium or chromium is covered by patent 2,369,709, obtained by H. N. Baumann, Jr., and R. C. Benner, of the Carborundum Company, Niagara Falls, N. Y.

Purer Petroleum

► REMOVAL of mercaptans and other trouble-making sulfur-acid compounds from petroleum products by adding pyrogallol or a similar oxygen-bearing chemical, in the presence of a small amount of wood tar oil acting as an oxidation accelerator. Patent 2,369,771, issued on this process to D. C. Bond of Northbrook, Ill., is assigned to the Pure Oil Company.

Vitamin B Compound

► COMPOUNDS of pantothenic acid, one of the vitamin B series, are made by a process under patent 2,369,839, granted to Marjorie B. Moore of Waukegan, Ill., and assigned to Abbott Laboratories. Pantothenonitrile, pantothena-

midic, and the double salts of the latter are among the compounds described.

Riboflavin from Milk

► ANOTHER highly valuable vitamin, riboflavin, is obtained from milk whey and other materials that are now more or less of a drug on the market, in a process developed by R. E. Meade and H. L. Pollard of Appleton, Wis., and N. E. Rodgers of Madison, Wis., and protected by patent 2,369,680.

Pectin-Milk Pudding

► PECTIN, the stuff that makes jelly "jell," is combined with milk to form ultra-smooth chocolate puddings, pie fillings, and the like, by Aksel G. Olsen and Ellis R. Fehlberg of Battle Creek, Mich., who have assigned rights in their patent, No. 2,369,846, to the General Foods Corporation.

New Wood Preservative

► DINITROTOLUENE, milder brother of TNT (which is trinitrotoluene when spelled all the way out) is combined with chlorine to make a new preservative that protects wood against the attack of fungi. Two duPont chemists, A. L. Flenner of Wilmington, Del., and F. H. Kaufert of St. Paul, Minn., received patent 2,369,959 on their formula.

Vitamin D₂ In Penicillin Mold

► THE SAME MOLD, *Penicillium notatum*, that yields penicillin can be made a good source of rickets-preventing vitamin D₂ by irradiating it with ultra-violet light. Getting double value out of it in this way may help cut the cost of penicillin, it is suggested by three Swedish scientists, Dr. Ragnar Nilsson,

Dr. Nils Olsson and Dr. Per Eric Nilsson, all of the Swedish Agricultural College at Uppsala.

The suggestion is made in a newly published memorial volume celebrating the sixtieth birthday of the eminent Swedish physicist, Dr. Thé Svedberg of the University of Uppsala.

Classics of Chemistry:

**Beryllium was Found in the Aqua-marine
By a Chemist of the French Directoire**

The Sweet Element

► KNOWN for nearly 150 years, beryllium, lightest metal of the Alkaline Earth Group of elements, suffers by occurring almost exclusively in gem minerals. Emerald, beryl, aquamarine—these are the ores of this light, strong metal.

Citizen Vauquelin of the brave, new world that followed the French Revolution did not hesitate to grind up 100 parts of beryl and fuse it with caustic potash, nor to pay his respects to chemists who did not consider it worth while to be accurate about checking their mineral analyses. He was rewarded by the discovery of a new al-

kaline earth which forms sweet-tasting salts.

The metal beryllium was first seen by Wöhler who, despite his reputation as the founder of organic chemistry, was a mineralogical analyst at heart.

Authority on the history and compounds of this little known element, and on determination of its atomic weight, is the American chemist's own Charles L. Parsons, Secretary of the American Chemical Society. His "Chemistry and Literature of Beryllium," Easton, Pa., 1908 is the standard reference on the subject.

Beryllium

ANALYSIS OF THE AQUA-MARINE OR BERYL; AND THE DISCOVERY OF A NEW EARTH IN THAT STONE. Read before the French National Institute 26 Pluoise, in the Year VI. (Feb. 14, 1798.) By Citizen Vauquelin. In Nicholson's Journal of Natural Philosophy, Chemistry, and the Arts. Vol. II. London: M.DCC.XCIX (1799).

► THE ANALYSIS of minerals is one of those operations which are usually considered to be of little importance and are submitted, by chemists of the first order, as unworthy of their care, to the manipulation of their pupils.

I am well aware that the greater number of analyses afford results of little importance, which do not repay the labour and the time bestowed in

obtaining them. I am likewise aware that they do not offer so brilliant a prospect, nor promise to afford results of so general a nature, as the plan of operation which has been formed with regard to some of the most important points in chemistry. But I am not, from these reasons, of opinion, that this class of processes, which has likewise its difficulties, and requires, for its successful conduct, a certain series of reasoning and particularly an exact knowledge of the bodies described; I am not of opinion that it is so little entitled to engage the attention of philosophical chemists. For they must recollect, that it has afforded them the solid foundation of their theories, and new objects for the exercise of their abilities.

From a disregard of this kind it was that Bergmann, whose active mind could not submit to the details of experiment, has committed so many faults, by trusting his operations to young pupils, who had not acquired the habit of distinguishing new substances from those which were already known.

The analysis of the beryl, already made by Bindheim, will be a proof of what I here advance. It is composed, according to him, of silex 64, alumine 27, lime 8, and iron 2.

Citizen Haüy having found a perfect agreement between the structure, hardness and weight of the beryl and the emerald, engaged me, some months ago, to compare these two stones by chemical means also, in order to know whether they were composed of the same principles in similar proportions.

The most interesting circumstance to the Institute in this result being a new earth, which I have discovered in the beryl, I shall pass slightly over the other subjects, and dwell more particularly on its distinctive properties.

The Method of Analysis

Experiment 1. One hundred parts of beryl reduced to fine powder were fused with 300 parts of caustic potash; the mass, after cooling, was diffused in water, and treated with the muriatic acid; by this means the solution was completed.

The muriatic solution was evaporated to dryness; toward the end of the evaporation the fluid assumed the form of a jelly; the dried matter was then diffused in a large quantity of water. Part of the matter was dissolved; but a white, granulated transparent powder remained. This substance, collected

on a filter, washed with much water, and dried by ignition, weighed 69 parts. It had all the properties of silex.

Experiment 2. The fluid separated from the silex was precipitated by the carbonate of potash of commerce; the precipitate collected and drained was treated with a solution of caustic potash. The greatest part of the matter was dissolved; but there remained a certain quantity of earth which was not taken up. This being separated, washed, and dried by ignition, was of a brown greyish colour; it weighed nine parts. In these nine parts it is that our new earth is contained. We shall speak of it again in the subsequent part of this Memoir.

Experiment 3. The alkaline solution of the foregoing experiment was supersaturated with muriatic acid, until a perfect solution took place, and this was again precipitated by the carbonate of potash of commerce: the deposition, washed and dried by a red heat, weighed 21 parts.

This substance appeared to me at that time to be pure alumine. We shall see what conclusion ought to be made, after examining the properties of the new earth which I have announced.

Experiment 4. The nine parts in *Experiment 2* remaining after the action of the potash, and in which I announced the existence of a new earth, were dissolved in the nitric acid; the solution was evaporated to dryness, and the residue again dissolved in water. The solution of this substance having assumed a reddish yellow colour, which indicated the presence of iron, a solution of the hydro-sulphuret of potash was mixed with it; a black voluminous precipitate was formed;

the fluid was heated in order to favour the union of the parts, after which the fluid was decanted clear and colourless. The black precipitate by calcination became of a red brown colour, and weighed one part. When dissolved in the muriatic acid, and the solution evaporated to dryness, it afforded a beautiful blue when an atom of the matter was thrown into a solution of the Prussiate of potash: it was therefore the oxide of iron.

The fluid from which this oxide had been separated was again evaporated to dryness; and though at first it had no colour, it nevertheless became red toward the end of the process, and the residue preserved that colour. This residue having been left for 24 hours in a capsule, became reduced into a kind of gelatinous fluid, of a yellowish red colour; cold water poured thereon dissolved the whole mass; but the solution was red and turbid: by exposure on the heated sand-bath, red flocks were separated, and the fluid became as clear as water. These flocks, carefully separated, washed and dried, weighed half a part: it was also the oxide of iron; which, with the part before obtained by means of the hydrosulphuret of potash, makes one part and a half of that substance.

Experiment 5. The earth being thus perfectly deprived of the oxide of iron, I separated it from the nitric acid by means of the common carbonate of potash; and I obtained 12 parts of a white earth, soft beneath the fingers, and soluble in acids with effervescence.

We see that this earth, in its separation from the nitric acid, did absorb four parts and a half of carbonic acid; since out of nine which were subjected

to experiment, one and a half of the oxide of iron were obtained; which leaves 7.5 for the earth contained in the 12 parts of carbonate last precipitated.

Properties of the new Earth

Experiment 1. The 12 parts of earth united with carbonic acid, as before mentioned, were put into sulphuric acid, which dissolved them completely with effervescence. The solution had a very saccharine taste at first, and astringent at last. The solution left till the following day afforded irregular crystals, very solid and saccharine like the solution which afforded them.

Experiment 2. These crystals were again dissolved in water; the solution mixed with sulphate of potash did not afford alum either immediately nor by evaporation, as happens in the alumine when combined with sulphuric acid. Each of these salts crystallizes separately, without contracting any union.

I repeated this operation five times in succession, with different doses of sulphate of potash, without obtaining more success than at first. At last, to convince myself of the difference between this earth and alumine, I took equal quantities of the one and the other; and after having dissolved them in the sulphuric acid, I mixed them with like quantities of sulphate of potash. I constantly obtained octahedral alum with the alumine; but the earth of the beryl afforded only an irregular salt.

These differences first discovered between the two earths, induced me to seek for others, by comparing them in a greater number of points.

Comparison with Alumine.

Experiment 1. For this purpose, I

separately dissolved equal quantities of alumine and of the earth of beryl in nitric acid, to perfect saturation.

The salt which arose from the combination of the earth of beryl with the nitric acid, did not appear susceptible of crystallization; it strongly retains moisture; by dessication it becomes converted into a kind of ductile paste, which, when exposed to the air, powerfully attracts moisture. Its taste is at first very sweet, and afterwards astringent.

Experiment 2. The nitrate of alumine likewise crystallizes with considerable difficulty; but it does not attract moisture so strongly. Its taste is not saccharine, like that of the nitrate formed with the earth of beryl.

I made the following comparative essays of the solution of these two salts, using equal quantities of each.

1. The nitrate of alumine, mixed with a solution of nut-galls in alcohol, afforded no precipitate. The fluid simply acquired a slight greenish colour, and lost somewhat of its transparency; however, at the expiration of some hours, the fluid, having been diluted with water, let fall a greyish precipitate.—2. The salt of the earth of beryl, mixed with the same re-agent, immediately afforded a deposition in flocks of a yellow brown colour.

3. The nitrate of alumine, mixed with the oxalate of potash, immediately afforded a precipitate in the form of very abundant white flocks, which subsided to the lower part of the vessel, and left the superior fluid perfectly clear.—4. The salt of the earth of beryl, with the same re-agent, did not afford the slightest appearance of a precipitate, even after several days.

5. The nitrate of alumine, mixed

with tartrite of potash, immediately formed a deposition in flocks, and the super-natant liquor became clear and colourless.—6. The salt of the earth of beryl, with the same re-agent, did not produce any sign of precipitation after several days.

7. The nitrate of alumine, mixed with a solution of the phosphate of soda, afforded a gelatinous semi-transparent precipitate, which subsided very slowly.—8. The salt of the earth of beryl also formed a precipitate with the same re-agent; but it was less gelatinous, and less transparent, and it also fell down more speedily.

9. The nitrate of alumine, mixed with very pure Prussiate of potash, instantly afforded a very abundant whitish precipitate, which became green at the end of a few hours.—

10. The salt of the earth of beryl, with the same re-agent, afforded no precipitate even after several days.

11. The nitrate of alumine, mixed with a saturated solution of potash, afforded a gelatinous magma, which was semi-transparent, and soon became filled with numerous bubbles of gas, which raised it to the upper part of the fluid.—12. The salt of the earth of beryl, mixed with the same re-agent, afforded a precipitate in flocks, which was not filled with bubbles like the foregoing, and which fell to the bottom of the liquid.

13. The nitrate of alumine, mixed with a solution of caustic potash, at first afforded a gelatinous deposition, which was afterwards taken up by the excess of alkali.—14. The salt of the earth of beryl, treated with the same re-agent, was affected in the same manner, excepting only that a larger quan-

tity of alkali was required for the second solution.

15. The nitrate of alumine, mixed with a solution of carbonate of ammonia, formed a precipitate which was not re-dissolved by an excess of alkali.—16. The salt of the earth of beryl, mixed with the same re-agent, afforded a precipitate which was entirely re-dissolved by an excess of alkali.

We see by most of these experiments, that the earth of beryl essentially differs from alumine, which however it resembles much more than any other earth, and with which it may even be easily confounded in certain respects.

But the experiment which induced me to fix my opinion irrevocably with respect to this earth, was that which shewed the comparative degree of attraction of the two earths for the same acid.

To acquire this knowledge, I dissolved in the nitric acid twelve parts of very pure alumine, and evaporated to dryness, in order to expel the surplus of acid which was in the fluid. The residue being dissolved in water, I added to the solution ten parts of the earth of beryl, recently precipitated from its solvent, well washed, and still moist.

I added no more than ten parts of the earth of beryl, to precipitate the twelve parts of alumine, though I had ascertained, by other experiments, that a somewhat greater quantity of the earth of beryl than of alumine was necessary to saturate the same quantity of acid; but I chose rather that a small quantity of alumine should remain in solution, than that any portion

of the earth of beryl should mix with the precipitate. When therefore the mixture had thus been made, I boiled the fluid for a quarter of an hour, then filtered it, and retained on the filter the earthy precipitate. After washing this, I combined it with the sulphuric acid, and evaporated to dryness, in order to expel the excess of acid; after which, re-dissolving it in water, I added a few drops of sulphate of potash to the solution, and obtained octahedral crystals of alum.

Now it is evident that the earth of beryl has more affinity with the nitric acid than alumine has, and consequently that it is not the same earth. If the earth of beryl be not alumine, there is much greater reason to decide, that it is not one of the other known earths; for it differs much more from them than from alumine. I therefore consider this earth as a new substance, different from all those we are yet acquainted with. It is true, that it in some measure resembles alumine, namely, in its softness to the touch, its adhesion to the tongue, its levity, its solubility in potash, and its precipitation from its solutions by ammoniac. But it differs from alumine in its other properties. Its combinations with acids have a very saccharine taste; it has a stronger affinity with those solvents; it does not afford alum with the sulphuric acid and the potash; it is totally soluble in carbonate of ammoniac; and lastly, it is not, like alumine, precipitable from its solutions by the oxalate and the tartrate of potash.

This earth being soluble in caustic potash, like alumine, we can no longer trust to this simple character to ascertain the presence of the latter earth; for it may happen that the earth of

beryl should be taken for alumine, or a mixture of both for one or the other of these pure earths. It will therefore be necessary, whenever an earth soluble in potash is found, to endeavour to convert it into alum by the known methods. If it does not afford alum, it may certainly be concluded that it is not alumine. But it may possibly afford alum, and nevertheless contain the earth of beryl; a mother water will then remain, in which this last earth will be suspended.

To separate the small quantity of alum, which likewise remains in this mother water, it will be proper to decompose it by a solution of the carbonate of ammoniac added in excess; by this means alum will be entirely precipitated, and the earth of beryl will remain dissolved in the carbonate of ammoniac. This earth may afterwards be readily separated, by boiling the solution for a certain time. The heat will drive off the carbonate of ammoniac, and the earth will fall down in the form of a powder.

By comparing the results of the analysis of the beryl with those which Klaproth and myself obtained from that of the emerald, we might conclude, that these two stones are very different from each other; for I found that the emerald was composed of 64 of silex, 29 alumine, 2 lime, between 3 and 4 of the oxide of chrome, and

1 or 2 of water; whereas the beryl is composed of 69 silex, 21 alumine, 8 of the peculiar earth, and $1\frac{1}{2}$ of the oxide of iron.

But since that time I have found that the emerald likewise contains this new earth; whence it follows, that the emerald and the beryl are one and the same substance, differing only in their colouring matter.

With regard to the proportion in which I have obtained this earth of the beryl, I do not give it as strictly accurate; for it is possible that part may have been dissolved at the same time as the alumine by the potash.¹

I have not yet thought it proper to give a name to this earth. I shall wait till its properties are better known; besides which, I should be glad to have the advice of my brother-chemists on the subject.²

In the second memoir, I shall speedily give the most complete account in my power, of its combinations with the acids and some of the combustible bodies.

¹ Since the above was written, I have ascertained, that there was in fact a certain quantity of the earth of beryl dissolved by the potash with the alumine; and that instead of 8 per cent, the beryl contains 16.

² The most characteristic property of this earth, confirmed by the latest experiments of our colleague, being, that it forms salts of a saccharine taste, we propose to call it Glucine, sweet. . . . Note of the Editors of the Annales.

Vauquelin's Second Memoir

INFORMATION RESPECTING THE EARTH OF THE BERYL;
in Continuation of the First Memoir on the same Subject. By Citizen Vauquelin.

I have announced in my Memoir of

the Earth of the Beryl, that this fossil contains about 8 per cent of that principle: but at the same time I observed, that I did not consider this proportion as being very accurate, because I presumed that a certain quantity had been

dissolved by the potash employed to separate the alumine.

I also announced that I had begun some trials, to ascertain whether the alumine contained in the beryl was in fact contaminated by a mixture of this new earth. The result of these experiments, related in a few words, will form the subject of the present communication to the Institute, together with an account of certain properties of this substance, of which I have since extracted a larger quantity.

Experiment 1. I put together the alumine which had been obtained from three docimastic quintals of beryl, which had been analysed in the same number of separate operations. The quantity was 63 grammes. I dissolved them in sulphuric acid, and, after having (bréveté) the solution, I submitted it to evaporation to obtain the alum. The evaporation was continued until crystals were no longer afforded. The remaining mother water was very saccharine and thick.

Experiment 2. I mixed this mother water with a solution of carbonate ammoniac more than sufficient to saturate the acid. The mixture was repeatedly shaken during twenty-four hours. I perceived that the bulk of the precipitate thrown down by the first portions of the carbonate had very perceptibly decreased. At the expiration of that time I filtered the fluid, to separate the undissolved part: this last, after washing and ignition, weighed 5 grammes, and had all the properties of alumine.

Experiment 3. I exposed the ammoniacal solution to the action of heat in a capsule of porcelain: as soon as the temperature was sufficiently ele-

vated to drive off the carbonate of ammoniac, a large quantity of a white, granulated, and very voluminous earth was deposited. I continued the evaporation until all the ammoniacal salt was dissipated. I then threw the residue upon a filter, and washed it with much water. This residue, after drying by a gentle heat, was perfectly white, pulverulent, and soluble in acids, with a strong effervescence. It weighed 42 grammes, which by a red heat were reduced to 25 grammes; whence it follows, that these 42 grammes contained 17 grammes of carbonic acid and water.

Consequently, the three quintals of beryl having afforded 24 grammes of the new earth which was not dissolved by potash, and the alumine which these three quintals afforded having also, as has been just observed, 25 grammes of the same substance, it is evident that each quintal of beryl contains 16.33. One hundred parts of beryl are therefore composed of

69	parts silex,
16	earth of beryl,
13	alumine,
1	oxide of iron,
0.5	lime.

99.5

Experiment 4. I have observed in my first Memoir, that alumine dissolved in the nitric acid was precipitated by the earth of beryl. I was desirous of knowing whether the same phenomenon would likewise take place with alum. I therefore dissolved one hundred parts of this salt in about six hundred parts of hot water. The solution afforded crystals of alum. Into this solution I put a certain quantity of

the earth of beryl, recently precipitated from a solution by ammoniac, and well washed. The mixture was boiled for an hour. I soon perceived that the earth of beryl was taken up; and in proportion as the excess of acid in the alum was saturated, there fell down a great quantity of earthy matter, in white flocks, in a very divided state. As soon as the decomposition appeared to me to be complete, I filtered the liquor, and collected the precipitated earth, which, when washed and dissolved in the sulphuric acid, afforded, with a sufficient quantity of sulphate of potash, crystals of alum perfectly octahedral.

The fluid from which the alumine had been separated possessed a very saccharine taste; and, when subjected to evaporation, it did not afford alum. Hence we find, that the earth of beryl has a greater affinity than alumine with respect to the sulphuric acid, as well as the nitric.

Experiment 5. Being desirous of ascertaining still more effectually the difference which exists between alumine and the earth of beryl, I dissolved ten parts of the former earth in the sulphuric acid; and after having added the necessary quantity of sulphate of potash, I obtained, by several successive crystallizations, 90 parts of alum. I also dissolved 10 parts of the earth of beryl in the same acid, and added the same quantity of sulphate of potash. I obtained only 50 parts of salt in small crystalline grains, of which I could not determine the figure. This salt is soluble in 7 or 8 parts of cold water, a quantity very insufficient to dissolve alum at the same temperature.

There cannot, therefore, remain any

doubt concerning the particular nature of the earth contained in the beryl; which must henceforward be reckoned in the number of substances of this order, of which it will compose the eighth species.

It almost always happens in the sciences of observation, and even in the speculative sciences, that a body, a principle, or a property, formerly unknown, though it may often have been used, or even held in the hands, and referred to other simple species, may, when once discovered, be afterwards found in a great variety of situations, and be applied to many useful purposes.

Chemistry affords many recent examples of this truth. Klaproth had no sooner discovered the different substances with which he has enriched the science, but they were found in various other bodies; and if I may refer to my own processes, it will be seen, that after I had determined the characters of chrome, first found in the native red lead, I easily recognized it in the emerald and the ruby. The same has happened with regard to the earth of the beryl. I have likewise detected it in the emerald; in which, nevertheless, it was overlooked both by Klaproth and myself in our first analysis: so difficult it is to be aware of the presence of a new substance, particularly when it possesses some properties resembling those already known!

Though I have not yet determined with much accuracy the proportion in which this earth exists in the emerald, I think, nevertheless, that it is nearly the same as in the beryl; but I shall ascertain this point with more certainty in my second analysis. The emerald

and the beryl are therefore two stones of the same nature, excepting the colouring part; and the sciences of crys-

tallography and chemistry are here also perfectly consistent in their results.

A Table of the general Properties of the Earth of the Beryl

1. It is white.
2. Insipid.
3. Soluble in water.
4. Adhesive to the tongue.
5. Infusible.
6. Soluble in the fixed alkalis.
7. Insoluble in ammoniac.
8. Soluble in the carbonate of ammoniac.
9. Soluble in almost every one of the acids (except the carbonic and phosphoric acids).
10. Fusible with borax into a transparent glass.
11. Absorbs one-fourth of its weight of carbonic acid.
12. Decomposes the aluminous salts.
13. Is not precipitable by well-saturated hydro-sulphurets.

A Table of the specific Characters of the Earth of Beryl

1. Its salts are saccharine, and slightly astringent.
2. It is very soluble in the sulphuric acid by excess.
3. It decomposes the aluminous salts.
4. It is soluble in the carbonate of ammoniac.
5. It is completely precipitated from its solutions by ammoniac.
6. Its affinity for the acids is intermediate between magnesia and alumine.

None of the known earths unite the six properties announced in this table.

I present to the Institute a certain quantity of this earth, and shall produce at one of its future sittings a

series of combinations formed with this earth, extracted from a considerable quantity of beryl given to me by Citizen Patrin, whose zeal for the advancement of the sciences is well known to every one of their cultivators.

Heavy Rolling of Sole Leather Improves Wear

► **HEAVY** rolling of shoe sole leather, or compression by other means, produces an improvement in wear, it was found by recent tests made by the National Bureau of Standards, in which a regiment of soldiers in an officer candidate camp were used, together with some civilian workers in war industries.

Differences in the wearing quality of 20 commercial tannages of vegetable sole leather were very small, with no significant difference in the wear of

leather tanned from domestic and from cold-storage hides. They showed water-soluble materials and grease are lost from soles in service, the greatest loss being shown in water-soluble ash.

The so-called "rubber" abrasive machines are of little use, it was found, in predicting the wearing qualities of tannages. The wearing quality can be estimated, to a degree, by the water-soluble content, the firmness, and the degree of tannage of the leather.

Who's Who in Beryllium

LOUIS NICOLAS VAUQUELIN (1763-1829) was a French state chemist in the years after the Revolution. An ardent analyst, he discovered two elements, chromium in 1797, beryllium in 1798. He published an immense number of papers. His interests ranged through mineralogy, assaying, mining, pharmacy and medicine, in addition to teaching.

FRIEDRICH WÖHLER (1800-1882) was trained as a physician but was lured into chemistry by friendship with such eminent chemists as Gmelin, Berzelius and Liebig. Wöhler obtained metallic beryllium by heating the chloride with metallic potassium, the method he had used to isolate aluminum, in the same

year that he synthesized urea and opened the field of organic compounds to the chemists' curiosity.

CHARLES LATHROP PARSONS (1867-) did his researches on beryllium while professor of chemistry at the University of New Hampshire. In 1911 he became chief mineral chemist of the U. S. Bureau of Mines, later serving as chief chemist through the days of the First World War until 1919, when he devoted the major portion of his energies to the American Chemical Society of which he has been secretary since 1907. He has played a leading role in the growth of this important professional society and has received many honors here and abroad.

Answers to Chem Quiz on Page 27

1. Cupric sulfate, CuSO_4 (e).
2. Mercurous chloride as medicine, HgCl (a).
3. Calcium hypochlorite, $\text{Ca}(\text{ClO})_2 \cdot 4\text{H}_2\text{O}$ (h).
4. Ferrous sulfate, FeSO_4 (f).
5. Potassium bitartrate used in cooking, $\text{KHC}_4\text{H}_4\text{O}_6$ (l).
6. Magnesium sulfate as medicine, MgSO_4 (x).
7. Zinc oxide, ZnO (c).
8. Ferrous sulfate, FeSO_4 (f).
9. Sodium thiosulfate in photography, $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (r).
10. Yellow lead oxide, PbO (s).
11. Potassium sulfide, K_2S (n).
12. Silver nitrate, AgNO_3 (w).
13. Sodium ammonium phosphate, $\text{NaNH}_4\text{HPO}_4 \cdot 4\text{H}_2\text{O}$ (q).
14. Copper acetoarsenite as poison, $3\text{CuOAs}_2\text{O}_3 \cdot \text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$ (b).
15. Nickname for the poison, arsenic trioxide, from the alleged custom of the crown prince administering it to the king, As_2O_3 (g).
16. Ferric ferrocyanide as a pigment, $\text{Fe}_4(\text{Fe}(\text{CN})_6)_3$ (v).
17. Red lead oxide as a pigment, Pb_3O_4 (u).
18. Pharmacist's name for ammonium chloride, NH_4Cl (k).
19. Glauber's salt, sodium sulfate, Na_2SO_4 (o).
20. Sodium carbonate, Na_2CO_3 (p).
21. Probably relating to the wisdom of the alchemists, though it may sound silly to us: ammonio-mercury chloride, HgNH_2Cl (j).
22. Potassium nitrate, KNO_3 (m).
23. Calcium hydroxide, $\text{Ca}(\text{OH})_2$ (i).
24. Lead acetate, $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$ (s).
25. Zinc sulfate, ZnSO_4 (d).

What Courses Chemists and Chemical Engineers May Most Profitably Study

Training for the Chemical Profession

Reprinted from a pamphlet of the American Chemical Society

THIS ARTICLE, part of a report by a committee of the American Chemical Society, answers the questions regarding what those who wish to be chemists or chemical engineers should study. The portions of the report covering the scope and the types of work of the chemical profession appeared in CHEMISTRY for February and March.

► A THOROUGH training in mathematics and physics is necessary since facility in the use of both and the ability to think mathematically are required for work in chemistry and chemical engineering. Even in those fields of chemistry that have not as yet been found capable of mathematical treatment, the chemist should have the type of mind that is at home in mathematics and physics.

Many employers of chemists and chemical engineers complain of the lack of ability on the part of technical men to speak and write clearly and concisely. Employers place great emphasis on this type of training. Chemists and chemical engineers, therefore, should have an excellent background in English.

Facility in the use of foreign languages is desirable. The editorial staff of *Chemical Abstracts*, a publication of the American Chemical Society, regularly reviews scientific publications in thirty-two languages. German is of particular importance because of

the large amount of scientific and technical information which has been published in that language. French and Russian are next in importance. Spanish and Portuguese are recommended to those who expect to work in Latin American countries.

In Secondary School

The high school program should include algebra, plane and solid geometry, trigonometry, and advanced algebra, if available.

Courses in physics and chemistry in secondary schools are very elementary, but from them students should learn the simple facts and principles thoroughly. High school training in chemistry is desirable, although a student may become a chemist or chemical engineer without it.

The high school curriculum should include at least one foreign language, not only to meet college entrance requirements but to give a foundation for the study of language.

Subjects in the social and biological field, such as sociology, biology, and geography, should be included in high school training in science, since these will awaken an interest in a broad training and tend to prevent overspecialization.

Mechanical drawing and shop work of a limited amount are recommended.

Some work in history and government and appreciation of art and music

should also be included in the high school program.

A course in stenography, particularly for girls, is very desirable, since it opens a field of opportunity as a technical secretary if additional college training in chemistry is taken.

A thorough training in English is of great importance. A knowledge of grammar and composition is fundamental, while an appreciation of English literature is highly desirable. The ability to write and speak clearly is necessary in every walk of life. A deep and broad foundation should be laid while in high school, for it is difficult to remedy language defects in college.

High school training does not involve specialization since preparation for all science professions is practically the same.

In College or University

After completion of high school, the training obtained in a four-year college course leading to the bachelor's degree in science, engineering, or arts is the initial background for the practice of chemistry.

Colleges and universities teaching chemistry or chemical engineering generally arrange elective and required subjects to suit the objective sought. Most colleges and universities in the United States meet the general standards designated as "of recognized standing" as set up by "American Universities and Colleges" published by the American Council on Education, which is used as a guide by the various State Departments of Education. A list of these institutions may be found also in the annual Educational Directory of the U. S. Office of Education, Part III, "Colleges and Uni-

versities, Including All Institutions of Higher Education." Institutions that are accredited by national or regional associations are indicated.

General outlines of study have been set up by committees from the American Chemical Society and the American Institute of Chemical Engineers. These have been published with reports on accredited institutions.

A few universities require five or six years of study for a degree in chemical engineering, but most institutions grant a bachelor of science degree in this field at the end of four years' work. Undergraduate training is not given for a particular industry since the basic fundamentals for a career in any of the process industries are the same. With a thorough understanding of principles, specialization becomes possible later.

There is a growing tendency in the scientific and engineering professions to expect students to take more cultural subjects such as language, literature, history and social science, even at the expense of technical and professional subjects.

There are a few excellent junior colleges of standing that give the first two years of chemical work on an acceptable college level. With such background the needed additional courses may be secured in the junior and senior years of an engineering school or university with considerable profit to the student.

In Graduate School

The average competent and capable beginner in the chemical profession will find graduate training practically essential for research or teaching and often very desirable for other divisions

of the chemical profession. The survey of the membership of the American Chemical Society made early in 1944 shows that out of the 72 per cent who list chemistry rather than chemical engineering or some other field of science or engineering as their major interest, 42.5 per cent hold the doctor's degree and 23.8 per cent the master's degree. In marked contrast only 9.7 per cent of chemical engineers reporting in this survey have a Ph.D. or Sc.D. degree, but 26.2 per cent have the M.S. degree. The nature of the work done by chemists and chemical engineers largely determines how much graduate study is required and how much "training on the job" is possible. Specialization in the field that has been chosen is the keynote at this point. The student should consider carefully the institution where he plans to do his special work, so as to be certain it is outstanding in the particular field in which he wishes to become expert. The decision should be based on one's inclination and choice together with an evaluation of aptitude and fitness.

The master of science degree can usually be obtained by one additional year of full-time postgraduate work beyond the bachelor's degree. This degree shows evidence of additional training and often leads to a more responsible initial appointment.

There is a difference between taking advanced courses and completing the requirements for the doctor's degree. To obtain the degree, an original problem must be solved. Not all students of chemistry have research ability and only those who possess it should spend the time and effort required to obtain this degree. After some graduate work and while still a candidate for the mas-

ter of science degree, it is possible to decide whether a student has those qualities of ingenuity, vision, and persistence which research demands and whether he is justified thereby in continuing his work for the doctor's degree. However, some may wish to pursue graduate study, without credit toward a degree.

With increased specialization in the profession it is believed that graduate training for the doctor's degree should be undertaken only by those well equipped for the particular field chosen as a life's work.

The doctor's degree (Ph.D., Chem. D., or Sc.D.) requires a minimum of three full years beyond the bachelor's degree.

Since it is recognized that the degree of doctor of philosophy (Ph.D.), doctor of chemistry (Chem.D.), or doctor of science (Sc.D.) indicates a comprehensive educational background including original work, the doctor's degree has become a valuable asset to individuals seeking employment in the chemical profession.

It is less significant at present in chemical engineering than in chemistry, but even in this profession there is a growing tendency toward a fifth or even sixth year with the M.S. degree as evidence of the work done.

Professional Development

The efficient professional man never ceases to study. Chemistry is constantly and rapidly changing as research presents new theories and as these are applied. The chemist and the chemical engineer should maintain membership in scientific and technical societies, attend their meetings, and read their journals. This is an indication of pro-

professional interest, aids in establishing and maintaining contacts with new developments and with fellow workers, and usually leads to economic advantage. The failure to do this has prevented many individuals from attaining positions of responsibility and leadership.

Part-Time Study and Financial Aids

Finance is frequently the chief factor governing selection of a college or university. Many schools offer scholarships to a limited number of capable students. These defray and sometimes exceed tuition charges and are usually granted on a competitive basis. Failure to obtain a scholarship does not necessarily close the door to financially handicapped students. It often pays to borrow funds for a college education, and data compiled on earning power of those engaged in chemical work show that college trained individuals earn much more than those with only a high school education. Full-time employment for a few years after high school to obtain funds for college training has the disadvantages of deferring establishment in the profession and of loss of ability to study. If a gap between high school and college training is imperative, reduce this time to the absolute minimum.

Opportunities for student aid through employment in the college or university or in its community are factors to be considered. This type of aid is usually noted in the college catalog, but the time required for the courses of the chemical student is so great that outside employment is generally difficult.

Financial assistance for war veterans

who wish to enter a profession is being provided by the United States Government. This aid is available to those whose training was interrupted by war at any stage of progress from high school to graduate school.

Even if there is no financial need, the prospective chemist can gain valuable experience and training by employment in chemical industry. In periods of prosperity college students often can find summer employment in a laboratory or industrial plant.

Several institutions offer coöperative courses. Two men work alternately—one at a job in industry, the other attending classes at the institution. After periods of time which vary in different schools, they exchange places. This plan may require a somewhat longer time for graduation but it affords training which often can be recommended.

High school graduates in increasing numbers go to work in the chemical industry and study in evening classes at nearby colleges or universities. A long period of time—about 10 years—is required, but many such students obtain a bachelor of science degree in this manner. A part of college requirements may be met in this way, decreasing the time and expense for later courses in full-time residence. In spite of the long period of study required, this form of training is economically valuable to students who are determined to enter the field.

Scholarships, fellowships, and positions as assistants in the laboratory are offered by most colleges to graduate students. Sums paid by these grants are usually in addition to tuition so as to apply toward the living expense of the student. The student entering

graduate work will receive a less valuable monetary grant in the first year than after one or two years' training. There is widespread demand for these grants and selection is based upon the undergraduate record, personality, future promise, and recommendations of former teachers.

The opportunity for graduate work while employed is available only where universities are located in large industrial centers. However, by special arrangement with such institutions, study to complete requirements for the master's degree may be achieved by evening class procedure.

Guidance Opportunities

College students, both graduate and undergraduate, should keep their minds open in relation to future careers. When difficulties in the course are met, it is necessary to determine if these are due to inherent lack of aptitude or some other personal fault. No student should major in chemistry after it has been discovered that he can do more satisfactory work in some other field. Many persons who studied chemistry initially now work along

other lines. College deans, student advisers, and professors are always willing to help students with career problems, and also the advice of professional chemists should be sought. Vocational counsellors employed by state and national governments are particularly concerned with war veterans.

Association with students in school and college science clubs is of value. In many institutions the most capable students may be elected to fraternities and honor societies through which valuable contacts may be made and maintained.

This article is to supplement but in no way replace the guiding advice which students who desire to enter the chemical profession can obtain from high school counsellors. Such advice should be augmented by interviews with local chemists and chemical engineers.

Before planning a college course it is very desirable to obtain catalogs from several institutions. These may be found in school, college, and public libraries.

Streptomycin Shows Further Promise

► **HOPE** that still another group of microorganisms that plague mankind with disease and death may be brought under control by streptomycin, a remedy of the penicillin class, appears in a report by Dr. F. R. Heilman, of the Mayo Clinic, Rochester, Minn.

The germs are known as Friedlander's bacilli and also as *Klebsiella*. They occasionally cause a severe type of pneumonia and may also cause abscesses, ear trouble, meningitis, osteomyelitis, blood poisoning and a form of heart trouble. They are not uncommonly found in the sputum of patients with chronic bronchitis.

Streptomycin, Dr. Heilman and associates found, checked the growth of these germs in test-tube experiments. It protected mice from lethal doses of the germs.

Streptomycin was then given by Dr. W. E. Herrell to two patients who had respiratory infections, with *Klebsiella* persistently present in the sputum. The germs promptly disappeared from the sputum after streptomycin treatment was started.



➤ A GROUP of the Fourth Science Talent Search winners interested in chemistry gather round Dr. Roger Adams, head of OSRD chemical research, head of chemistry at the University of Illinois. Left to right are: Edward Kosower and Andrew Streitwieser of Stuyvesant High School, New York; Dr. Adams; Harold Conroy of Brooklyn N. Y. Technical High School; John H. Wahlgren of Valley, Nebr., High School.

At Age of 15, Science Talent Search Winner is Chemical Manufacturer

Modified Willgerodt Synthesis

by EDWARD MALCOLM KOSOWER

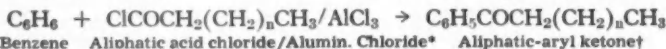
THE AUTHOR of this article is a senior at Stuyvesant High School, New York City and was aged 15 when he wrote it as part of his entry in the Fourth Annual Science Talent Search conducted by Science Clubs of America as a Science Service activity. This young chemist who lives in Brooklyn was awarded the top boys' \$2,400 Westinghouse science scholarship during the Science Talent Institute in

Washington in March. With several fellow students he has conducted a chemical manufacturing business in a basement laboratory under a corset shop in New York and has supplied specialty chemicals, such as amino acids, terphenyl derivatives and fluorene compounds to various university, industrial and governmental laboratories here and abroad. Turn the page to begin Kosower's essay.

► IN 1942, Schwenk and Bloch described briefly the use of morpholine and sulfur in the Willgerodt Synthesis. Previous to their innovation, the reaction using ammonium polysulfide as the basic-nitrogen-containing constituent had to be carried out in an autoclave and in small quantity. Based on a knowledge of this reaction, I believe that an intense study would bear rich fruit in the field of polycyclic aromatic hydrocarbons.

In short, this method consists of the conversion of an aliphatic-aryl ketone into an omega-aryl-aliphatic acid through an intermediate thiomorpholide complex. No conclusive observations can be made as yet in regard to the efficacy or the general nature of this modification, as the literature records the treatment of only eight ketones by two workers in this way.^{1,2} In only one instance was the aliphatic group other than methyl, thus, β -(6-Tetralyl)-propionic acid was prepared from the corresponding ethyl ketone.² The advantages of the method are chiefly the simplicity of the apparatus used, which is only a boiling flask equipped with a reflux condenser, and its applicability to large quantity preparations. Its chief disadvantages are the long heating periods required.

There are many instances which may be offered to illustrate the possibilities of the method in organic syntheses. The preparation of compounds of the general type $C_6H_5CH_2(CH_2)_nCH_2COOH$ where $n = 10$ or more might be effected as follows:



Benzene Aliphatic acid chloride/Alumin. Chloride* Aliphatic-aryl ketone†

*The acid chlorides can be prepared readily from the acids by the action of phosphorus pentachloride. The acids are obtainable commercially for very low prices.

I have already used this modified Willgerodt in the synthesis of β -Phenylpropionic acid from Propiophenone, as the starting point in a series of experiments to determine the effect of higher alkyl groups on the yield and ease of the reaction. To equivalent weights of sulfur and propiophenone was added an excess of morpholine. The sulfur dissolved with a change in color from light orange to deep red, and the whole was refluxed eleven and one-half hours. The mixture was then poured onto ice, and after the ice had melted, the water was decanted and the oily residue washed successively with warm water and warm ethanol. It could not be determined whether or not the thiomorpholide was actually oily. The thiomorpholide was hydrolysed to the acid with 10% Potassium Hydroxide by refluxing about fourteen hours. The resulting β -Phenylpropionic acid melted at $48^\circ C$. (lit. 49°).

Among the possible uses are conversion of diketones to the di-acids, and using this as a basis for the synthesis of coronene, an unusual polycyclic hydrocarbon, the synthesis of which has been accomplished only twice,^{3,4} and with great difficulty. To test the value of the conversion, I have prepared 1,4-Dicyanobenzene (Terephthalonitrile) from p-Dibromobenzene, according to the patent 828,202 (French). To the complex prepared from the calculated quantities of pyridine and cuprous cyanide, Eastman grade para-Dibromo-

†Willgerodt Modification: $C_6H_5CH_2(CH_2)_nCH_2COOH$ $n = 10$ or more.

dried and sublimed under reduced pressure to give pure 1,4-Dicyanobenzene. I intend to react this nitrile with methyl magnesium iodide in ether-benzene solution by refluxing until there is very little organo-metallic compound left as determined by a test on an aliquot portion. The resulting p-Diacetobenzene should be converted into p-Benzenediacetic acid by reacting it with morpholine and sulfur and hydrolysing. If this preparation proves promising, I shall attempt to synthesize Coronene from 9,10-Dibromobenzene through the nitrile (9,10-di-) in the following manner:



The scheme is self-explanatory. The only point where difficulty might be experienced is the unknown effect of an aliphatically substituted bromine atom on the Willgerodt modification.

A practical laboratory synthesis of Coronene (Newman's overall yield was about 1%; Scholl's even lower) would make available this material to physical chemists for research. Dr. Linus Pauling, eminent atomic structure expert, once remarked in a letter to Dr. Melvin S. Newman, who had synthesized the rare substance, "Coronene would clarify many puzzling problems in atomic structure if it were available in large enough quantity."³

In addition to its use in the synthesis of polycyclic aromatics, the modified Willgerodt reaction should find application in the synthesis of certain aryl-substituted aliphatic compounds. For instance, 10-Phenyl-1-Decene could be prepared from *n*-Octyl Phenyl Ketone via the Willgerodt, reduction to aldehyde, condensation with malonic acid, and decarboxylation.

Because of the comparatively smooth course of the modification, I shall attempt many studies which otherwise might have failed for lack of equipment and working material. In the future, I shall try to make a compre-

hensive study of the method including these possible phases: mechanism of the reaction, a factor which could probably be best determined by using branched-chain aliphatic phenyl ketones and studying the acids obtained from these; use of unsaturated ketones such as those which can be derived from vinyl, allyl, crotyl, and so on; effect of the reaction on such compounds as dibenzoyl ethanes, dibenzoylpropanes, etc.; the use of selenium and tellurium, the analogues of sulfur, in the reaction; and last, but not least, the effect of organo-metallic reagents on the intermediate thiomorpholide complexes.

It is interesting to note how the field of organic chemistry develops under scrutiny: from an extremely obscure topic, which, as yet, has occupied a total of one page in the *Journal of the American Chemical Society*, it expands so that a complete study such as I have outlined above would take years to complete. And, as far as possible, I will complete it.

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On the Back Cover

► THE GIRL AND BOY on the back cover are Miss Joswick and Mr. Kosower whose essays in the *Science Talent Search* appear in this issue. They are both shown with the exhibits they displayed during the hobby night of the *Science Talent Institute* in Washington. Miss Joswick is radiating some fluorescent minerals with an ultraviolet source. Mr. Kosower is showing some of the chemicals he has manufactured, along with their formulae.

Girl STS Winner Tells How She Built Mineral Collection

Minerals and Metals

by MARION CECILE JOSWICK

THIS ESSAY is by the winner of the \$2,400 girls' Westinghouse Science Scholarship of the Fourth Science Talent Search. The author is a 17 year old senior in the Brooklyn (N.Y.) Manual Training High School.

► WHAT CAN be more intriguing than the study of the silent mineral kingdom which lies concealed beneath our feet? In the course of our daily lives we tread unthinkingly upon the amazing history of our earth—the history written in the hills and fields around us.

I first became aware of the beauty of the mineral world at the age of eight when I paid my first visit to the Brooklyn Museum of Art. There I was captivated by a huge mass of translucent beryl and I decided then that I wanted to know more about this fascinating object and its mineral relatives. Ever since that moment, I have been working on my scientific project—collecting rocks, minerals and other geological specimens.

I began building my mineral collection with the pieces of quartz, mica, granite and slate that I found in the neighborhood. Soon I entered the stage in which new horizons beckoned me, and I desired to add to my collection those strange new minerals whose names I had encountered in books. I solved this problem by writing letters to various people in all parts of the United States, requesting mineral samples. As a result, I also have a collection of letters from numerous

kind and interested persons who sent me specimens and this helped keep my interest in mineralogy alive.

Many happy hours were spent in arranging, sorting and studying the minerals. As I handled each one, I tried to learn it thoroughly and read the story written in it. I also performed some simple determinative tests. The beautiful colors and odd forms of many of the minerals increased my curiosity and led me to ask my teacher of geography numerous questions. She professed an interest in the subject and encouraged me in my idea to found a mineralogy club.

The number of pupils who responded to my invitation to join the club was a pleasant surprise to me. After drawing up a constitution, we had many enjoyable meetings, discussing books on mineralogy and geology which we had read, examining new specimens, building personal collections and arranging the club collection. The club survived from the time I founded it while in the fifth grade until about two years ago.

Upon entering high school I became aware of the many different and interesting branches of scientific study which were closely related to mineralogy. Thereafter I studied general science, chemistry, physics and as much mathematics as I could crowd into my program and then began to delve into the mysteries of fluorescence. My dad aided me greatly in this new interest

by giving me an argon bulb and helping me to buy a colorful assortment of fluorescent minerals. On Parents' Night at school, I gave a lecture-demonstration of the fluorescent properties of certain of the minerals. I was called upon in my physics class to give a similar demonstration. Here I gave this elementary explanation of fluorescence: "Fluorescence is the emission of light in the presence of an exciting agent. It is due to the transition of an electron from its natural orbit caused by the absorption of a quantum of light. As long as the exciting agent is present, the electron oscillates from its natural orbit. This oscillation sets up a series of wave vibrations which falling upon our eyes produce the sensation of color." My friends and myself have often been delighted and amazed at this phenomenon. The field of luminescence holds untold opportunities for future research. It is another branch of science with which I should like to be associated in the future.

The main interest in my life and the branch of scientific study which holds me spellbound is metallurgy. Even in the beginning I was greatly attracted to the shining metals. For me there was a strange fascination in the processes a metal goes through before it emerges as a finished product.

Who has not marveled at the magnificent bridges and buildings of the great cities in which we live? And yet, when we examine them closely, we discover that they are constructed of the common everyday materials with which we are all familiar. Their sturdy frames are made of steel—that same steel which but a few days be-

fore was iron ore being excavated from a dark mine, later to be melted and reduced in a roaring furnace. Their imposing exteriors are made of marble, or granite, or sandstone, those same materials which we see around us daily. This is but one small example of how metals work for man. Today, in our complex civilization, we could not exist without metals. Metals have pictured the progress of civilization. Certain stages in man's advancement are designated by such names as "Gold Age," "Bronze Age," "Copper Age," and "Iron Age." Metals are the basis of modern industry and we would be lost without them. I, for one, should like to become a part of this living, breathing creature called "industry." For me, the greatest glory would be in playing a leading role in the life of the metals. It would be of the greatest honor, and I should feel that a privilege had been bestowed upon me if I could actively participate in developing this exciting field.

I know that I should like to become a research metallurgist. I wish to know more about these fascinating metals—from the moment they are torn from the dark caverns of the earth and separated from their ores, until they emerge as the thousand and one different articles without which life today would be much less comfortable.

It is my firm intention to enter a school of high standing where I may earn a degree in metallurgical engineering, then when I have acquired this background and training, I will go forth into the industrial world and attempt to become a helpful cog in the machine which is carrying on the work of the world.

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